TANGANYIKA

Annual Report
of the
Department of Agriculture
1954

PART II

1955
PRINTED BY THE GOVERNMENT PRINTER
DAR ES SALAAM

Price Shs. 6/50

7 OCT 1955

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CONTENTS

	Page
Introduction	i
Cotton and Other Crops:	
Progress Report of the Ukiriguru Agricultural Station for the Season 1953-1954	1
Progress Report of the Ilonga Agricultural Station, Eastern Province, for the Season 1954	22
The Colonial Agricultural Insecticide Research Unit, Ilonga, 1954 ...	31
Coffee:	
The Coffee Research Station, Lyamungu, Moshi—Summary of the work conducted during 1954	37
Summary of the work carried out at Maruku Coffee Station, Bukoba, 1954	43
An Account of the work at Mbosi Coffee Sub-Station, Southern Highlands Province for the year 1954	45
Sisal:	
Sisal Research Station, Mlingano, Ngomeni, Annual Report for the year 1954	46
Entomology:	
Annual Report of the Entomologist, Morogoro, for the year 1954 ...	59
Annual Report of the Entomologist, Lyamungu, for the year 1954 ...	62
Plant Pathology:	
Annual Report of the Plant Pathologist, Lyamungu, for the year 1954	70
Annual Report of the Plant Pathologist, Arusha, for the year 1954	77
Botany:	
Annual Report of the Botanist, Ukiriguru, for the 1953-54 Season ...	82
Fisheries:	
Annual Report of the Fisheries Officer (Fish Farming) for the year 1954	88
Annual Report of the Fisheries Officer (Marine) for the year 1954 ...	90
Soil Conservation:	
An account of the experimental work carried out by the Soil Conservation Service during 1954	93
Field Experiments:	
Report of the Agricultural Officer (Experiments), Iringa, Southern Highlands Province for the year 1954	95

PAGE

Coast Agricultural Station:

Annual Report of the Agricultural Officer (Coast Agricultural Station), Chambezi 1954 116

Government Food Farm:

Summary of the experimental work at Lupiro Food Farm, 1954 ... 120

Summary of the Annual Report, Mahiwa Experimental Station, Southern Province, for the year 1954... 121

Summary of the Annual Report of Mwanhala Agricultural Station, Western Province, for the year 1954 123

East African Agricultural and Forestry Research Organization Fertilizer Trials, 1954 125

Notes on Experiments carried out in the Northern Province, 1954 ... 126

Notes on Experiments carried out in the Tanga Province, 1954 ... 127

TANGANYIKA

ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE, 1954

Part II

INTRODUCTION

Whilst Part I of the Annual Report gives an account of the agricultural policy of the territory, Part II details the many and varied experimental activities carried out by and under the auspices of the Department during the year. It will be seen that many of the experiments continue over a period of years. A complete description since they commenced would make this report extremely bulky and so reference to previous reports may occasionally be necessary. For this reason the presentation is as similar as possible to that of the 1953 report.

The extent and tempo of Agricultural development in Tanganyika since the war has created a tremendous challenge to research workers to provide the information upon which sound development can only be built. That this challenge is being met by workers often operating under difficult conditions is reflected in these pages and I would like to record my appreciation of their work. The co-ordination of this work, dispersed over the very large expanses of the territory, is becoming a task of increasing difficulty and importance. A new post of Assistant Director, Research, has been approved for the financial year 1955/56. This will greatly facilitate a fully planned approach to the varied problems which arise, and will provide a channel for closer co-operation with the extension services.

J. R. P. SOPER,
Director of Agriculture

PROGRESS REPORT OF THE UKIRIGURU AGRICULTURAL STATION FOR THE SEASON 1953–54

COTTON SEASON

Planting:
Ukiriguru, 1st December 1953 to mid-January, 1954;
Lubaga, November, 1953 to January, 1954;
Cultivators, mainly November, 1953 to January, 1954.

Picking:
Mid-April until August.

Legal uprooting date:
15th September, 1954.

Rainfall for the period 1st October, 1953 to 30th June, 1954:
Ukiriguru: 24·34 inches. (March 0·15 ins.);
Lubaga: 25·89 inches. (March 3·73 ins.).

INTRODUCTION

Meteorology, Ukiriguru

At Ukiriguru the dominating feature of the season was the dry March; all results have to be reviewed in the light of this. Early rains were good, but there was a dry spell of nearly four weeks in late January/February. This was broken by just over 2 inches in late February, but only 0·15 inches fell in March. April/May rains were very good indeed, but there was not then time to make a new plant and allow cropping recovery, before the dry season winds started early in June.

(It is only the second time, in the 23 years that records have been kept at Ukiriguru, that there has been a March drought. Dry periods in January/February are more frequent, but these affect the cotton crop at an earlier stage; they are less harmful and there can be cropping recovery.)

Some areas had showers in March, and therefore did not suffer as much as Ukiriguru. Lubaga had just under 26 inches for the period 1st October, 1953 to 30th June, 1954, of which 3·73 inches fell in March.

Staff

Mr. M. H. Arnold was on vacation leave from 2nd April, 1954 to 16th July, 1954.

Mr. J. M. Munro was on vacation leave from 6th July, 1954 to 15th November, 1954.

Mr. H. Doggett continued at Ukiriguru as Botanist of the Department of Agriculture.

Mr. R. A. Brown, Field Officer (Agriculture) as Farm Manager, and Mr. A. D. P. Angelini, Junior Field Officer, continued their excellent work throughout the season.

Mr. I. S. Mkwawa, Assistant Agricultural Officer, went on vacation leave on 5th July, 1954, and at the end of his leave was transferred to Tengeru.

Visitors

During the season Ukiriguru was visited by, amongst others, His Excellency the Governor, Sir Edward Twining, by the Chairman and Mrs. Littlewood, by Dr. Toy and by Mr. and Mrs. Underwood, of the Shirley Institute, Manchester, by the United Nations Visiting Mission to Tanganyika, and by Mr. D. Rhind and Sir Geoffrey Clay of the Colonial Office.

In May, 1954 the East Africa High Commission Specialist Committee on Agricultural Botany held at Ukiriguru its third meeting; seven visiting members, and six visiting observers attended.

Show

An exhibition staged at the Sukumaland Show, held in July, 1954 at Ngudu in the Lake Province, was awarded the Sukumaland Show Committee Challenge Trophy for the best departmental demonstration and exhibit.

Lake Province Cotton

The 1953-54 production, over 91,000 bales, is far and away the record for the Lake Province—and it is reported that in addition there was crop loss by heavy late rains, and that much Grade B seed cotton was left unpicked or not sold. Had the March showers been more widespread the Provincial crop should have been even larger. The acreage planted to cotton was reported (R.A.D.A., Mwanza) as just over 216,000 acres, 30 per cent greater than the acreage reported for the 1951/52 season when the previous record of 71,000 bales was attained.

Using the official records of acreage, Fig. 1 shows the yields since 1930 in bales of lint per hundred acres. There has been a significant increase in yield per acre since 1941, when the average was around 22 bales per hundred acres—just about half of the present average. Part of this can fairly be claimed for the increased yield from the Ukiriguru seed issues, and part as a result of extension activities towards timely planting and better husbandry. Due regard however has to be given to the effects of development in the higher yielding lake shore areas, e.g. Geita District.

Given the existing seed stocks and present standards of husbandry, the most important factor in production is the acreage, timely planted.

Nineteen hundred and forty-eight, with an average of 44 bales per hundred acres, was an exceptionally good year climatically, with low loss from pests and diseases (the benefits of new seed and extension work were only starting). In 1949 all crops suffered severely from drought; food had to be imported on a large scale. In 1950 and 1951 much of the cotton was, for various reasons, markedly late planted—into February and even into March, and in 1950 there was severe American bollworm loss. The average for these two seasons was only 26 bales per hundred acres.

In the last three years, 1952, 1953, and 1954, the average works out very nearly the same each year—42 bales per hundred acres. These were by no means exceptionally good years, and each had its cropping difficulties; the acreages planted differed considerably, and also the seasonal influences on the crops. In all three, however, the majority of the cotton was timely planted.

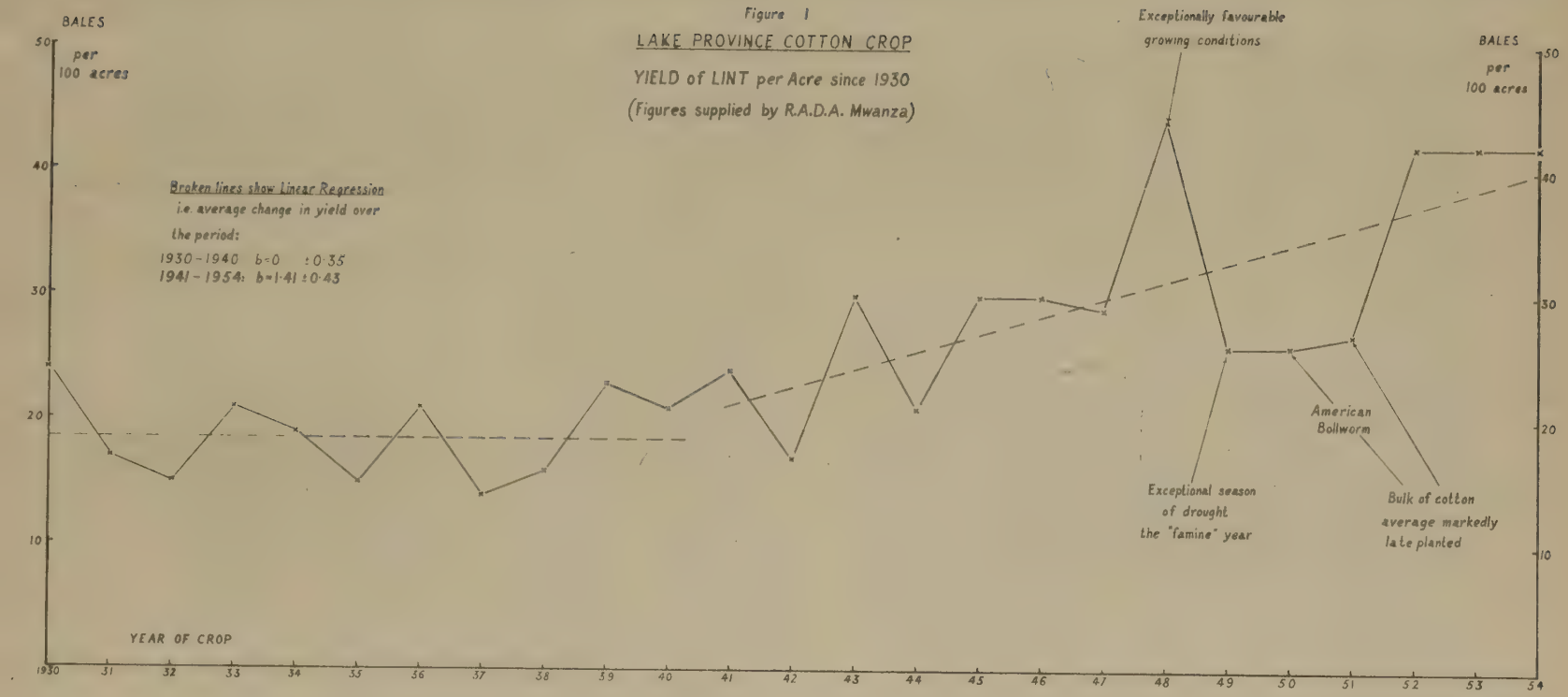
Taking the Province as a whole this season yields varied enormously; in the Shinyanga District they were especially poor; in the developing District of Geita, especially on the Lake fringe, they were very good indeed.

Figure 1

LAKE PROVINCE COTTON CROP

YIELD of LINT per Acre since 1930

(Figures supplied by R.A.D.A. Mwanza)


BALES per 100 acres
50
40
30
20
10
Broken lines show Linear Regression
i.e. average change in yield over
the period:
1930-1940 b=0 ±0·35
1941-1954: b=1·41 ±0·43
Exceptionally favourable growing conditions
Exceptional season of drought the "famine" year
American Bollworm
Bulk of cotton average markedly late planted
BALES per 100 acres
YEAR OF CROP
1930 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54

In the strain trials, in two of the Ukiriguru District plots, the mean yields of UK. 48/UK. 51 were around 2,000 lb. seed cotton/acre; in two others the mean yields were around 1,400 lb. seed cotton/acre; in five others they averaged around 1,000 lb. seed cotton/acre. Out of 16 district plots 2 were comparative failures. (Two of the district plot cultivators each received over Shs. 700/- from two-thirds of an acre of cotton.)

In the Lake Province Cotton Committee fertilizer trials, on hill sands, in the closely cultivated Mwanza, Bukumbi and Urima Chiefdoms, "over the fence" from Ukiriguru, the controls (581 shambas) averaged almost 600 lb. seed cotton/acre.

UK. 51 is to cover Geita District, and two sub-zones in the Mwanza District, in the 1954-55 season; UK. 48 is to cover the remainder of the Province, except for UK. 53 in Kome Island. UK. 46 is now out of cultivation.

This last season the hazard losses were not major factors affecting production. In general, loss due to insect pests was light. Bacterial blight was locally severe in some of the poorer areas, until checked by the February/March drought. In many such areas the new growth later in the season grew away from the disease.

With the high financial returns from cotton growing in the established areas of the Lake Province there is now a demand for extension to the more marginal fringes. Cotton has been tried before in these areas and given up mainly because of the hazards. Unless these hazards can be mitigated, poorer results than in the accepted areas are to be expected.

SUMMARY OF THE MAIN RESULTS AND PROGRESS

The Lake Province 1954 cotton crop, over 91,000 bales, is a record one. The significant improvement in yield per acre over the years is discussed, with reference to the improved seed issues and extension activities. UK. 48 was compared with MZ. 561 in 19 strain trials this season; the mean yield was 71 lb. lint per acre higher than MZ. 561.

The marked fall in yield, planting after mid-January, is discussed; under present conditions and in the absence of major hazards, it is shown that Provincial production is essentially dependent on the extent of the acreage planted before mid-January.

First and second residual responses after periods of land resting are somewhat less this season than reported in previous seasons, but on the whole worth-while.

The now classical Trial (8) continued to give interesting information. A striking result was the large response to the sulphate of ammonia top dressing on the portions of the trial dressed with cotton seed ash in 1944, and assumed therefore to be well supplied with phosphate. Sulphate of ammonia similarly top dressed to control plots gave no increase.

There were responses of the usual order to applications of organic manure and phosphate, direct and residual. On Ukiriguru the responses to top dressed nitrogen were very poor due to the drought. The Lake Province Cotton Committee district fertilizer tests gave phosphate responses similar to last year, and nitrogen responses better than at Ukiriguru.

The increased yields of the Ukiriguru seed issues compared to MZ. 561 are discussed, and the heavier yielding of some 8/290 strains over mean yields of UK. 48/UK. 51.

The programme of back crossing and selection continues. A start has been made adding B_{6m} to the best Ukiriguru strains.

The responses at Ukiriguru to seed treatment against bacterial blight are discussed.

Serious American bollworm attack was reported from the Musoma District. At Ukiriguru there were considerable populations of American bollworm moths, with egg-laying on sorghums and a succession of maize crops, but egg-laying on cotton was quite unimportant.

A report by Mr. P. H. Le Mare discusses some of his first results in the Ukiriguru portion of his work, which is to be extended when a suitable assistant can be stationed permanently at Ukiriguru.

GENERAL ACCOUNT OF THE WORK FOR THE SEASON

Husbandry

Time of Planting.—Over the years the need for timely cotton planting has been stressed as an all-important extension activity. Fig. 2 illustrates the results of the last two seasons which were droughty years. Planting up until nearly mid-January is reasonable, but a marked decline in cropping occurs when planting is delayed until the end of January into February. This past season the earliest planted cotton suffered slightly more from the March drought than did the late December/early January plantings; the very marked drop in yield, planting at the end of January, is striking.

With a one-crop season the cultivator can only start preparing land when sufficient rain has fallen. In the important cotton areas in the North of the Province, bulrush willet, the main food crop, need not be planted until mid January/February. The November, December, early January period should be used for cotton land preparation and planting. The penalties for delaying planting later than early January, should be appreciated. If planting is delayed until mid-January, the dry spells common at that time of year may delay germination into February, with the same effect as late planting.

Land Resting.—In Trial (5) second residual responses were measured, the third indicator crops, since digging-in the treatments. Only the continued response from the "tumbledown" fallow treatment was significant in the cotton portion of the trial; responses in the bulrush millet portion of the trial were also low.

In Trial (7), Table 1, first residual responses, second indicator crops, were less than in some years. There were for cotton the usual phosphate and compost responses, with fair responses following the planted fallow treatments, but with lesser effects following the "tumbledown" treatments. In the millet portion of the trial the increases were significant and appreciable.

Figure 2

YIELD AND PLANTING DATE

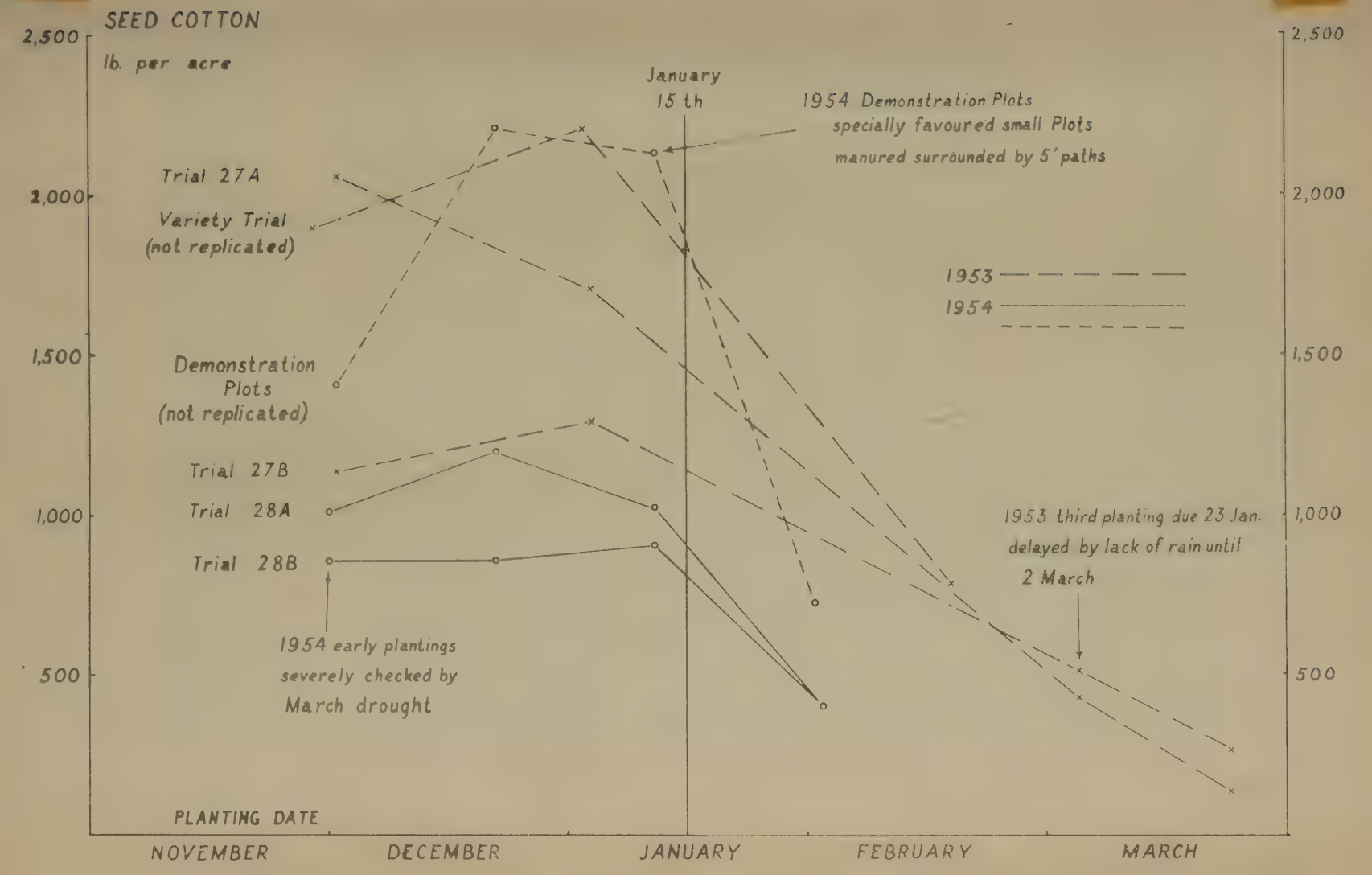


TABLE 1.—RESTING CROP TRIAL

Ukiriguru—Hill Sand—Trial (7)

Twelve blocks (six cotton: six bulrush millet) of eight plots of 1/48·4 acre. Cropping rotation—two years cotton: two years millet.

Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. Planted 8th December, 1953 (cotton); 8th January, 1954 (millet).

Five years' treatments, 1947-48 to 1951-52	Second Indicator Crops			
	Cotton		Bulrush Millet	
	Seed Cotton lb./acre		Grain lb./acre	
Annual cropping—no manure	864·	100%	573	100%
Annual cropping—double supers at 200 lb./acre applied 1952-53	1,034	120	790	138
Annual cropping—compost at 6 tons/acre applied 1952-53 ...	1,163	135	786	137
"Tumbledown" fallow—grazed	938	109	766	134
"Tumbledown" fallow—not grazed	985	114	779	136
Planted fallow—grazed	1,018	118	851	149
Planted fallow undersown with *Tephrosia* and *Crotalaria*—grazed	1,095	127	852	149
Planted fallow undersown with local creeping legumes—grazed ...	1,069	124	773	135
Sign. Diff. (P=·05)	Not significant		123	21
S.E.	±66·6		±43·0	

This past season a trial was laid down to test the effects of one season resting treatments. This is now under cotton for the 1954/55 season; and a second similar trial has been laid down, for cropping the following season.

At Lubaga the first results of a series of trials testing the effects of 3, 4 and 5 years' rest under *Cenchrus ciliaris* are coming in. There, the grass rest and "tumbledown" fallow give no increase in the first indicator crop, although there has been a small increase in the yield of cotton in the second year.

Manuring and Fertilizers.—The results from Trial (8) are given in Table 2. Millet was the indicator crop. The ninth residual responses are, as might be expected, only from the heavier manurial applications and the dressing of cotton seed ash. A particularly striking result is the response to sulphate of ammonia top-dressed to portions of the trial treated with cotton seed ash in 1944, compared to a similar top dressing to controls. (The ash plots are assumed to be amply supplied with phosphate). There was a spectacular increase—nearly 80 per cent of 480 lb. bulrush millet grain per acre. The same increase, this last season, would not have been got had cotton been the indicator crop—as is shown in the two NPD trials. Sulphate of ammonia similarly top dressed to control plots gave no increase. (Refer also to Mr. Le Mare's report). It is important in studying these agronomic responses to bear in mind the differences between cotton reactions, and the reactions of different grain crops.

TABLE 2.—MANURIAL TRIAL

Ukiriguru—Hill Sand—Trial (8)

Eight blocks of six plots, treatments applied in November, 1944. Half plots, each 1/35·6 acres, were manured at the same rates in November, 1952, or received sulphate of ammonia at 175 lb. per acre in March, 1953 and March, 1954.

Five-foot ridges, two rows at eighteen inches spacing. Native bulrush millet. planted 14th January, 1954.

Treatments	Yield of bulrush millet grain in lb./acre		
	Tenth indicator crop	Second indicator crop	Yearly applications
	Treatments applied 1944	Treatments re-applied 1952	S/Ammonia applied 1953 and 1954
Control—no manure	467	—	473
Compost—3 tons/acre	417	516	—
Farmyard manure—3 tons/acre	497	535	—
Compost—7 tons/acre	537	662	—
Farmyard manure—7 tons/acre	596	723	—
Cotton seed ash—1½ tons/acre	640	—	1,128
S.E.	±31·2	±44·6	±44·6
Sign. Diff. (P=·05)—			
in the same column	90	128	128
in the same line	—	96	—
not in the same line or column	—	120	—
Interaction: Ash × Nitrogen		+241	+‡28·0

In Table 3 are set out the results from Trial (9). In this trial the compost and phosphate responses are measured over a three year period, the nitrogen top-dressing being applied every year. The 1953/54 organic and phosphate results are responses in the year of application, but in addition there will have been accumulated residual benefits. The profits were especially large from the organic application; less, but still very worth-while, from the applications of double superphosphate. With compost and the heavier dressing of superphosphate, there was nearly a doubling of the crop. Responses to sulphate of ammonia were very small, only evident in the presence of phosphate. Better grown, lusher plants suffered more severely from the drought.

TABLE 3.—NPD EXPERIMENT

Ukiriguru—Hill Sand—Trial (9)

Main plots split to give 3 × 2 factorial, testing all combinations of:—

(Main plots) n_0, ... n_1 ... 0, 250 lb. sulphate of ammonia per acre.
(Split plots) d_0, ... d_1 ... 0, 6 tons compost per acre.
p_0, ... p_1, ... p_2 ... 0, 75, 150 lb. double supers per acre.

Six replications of twelve plots, each 1/69·7 acre. Compost applied 15th September, 1953 (also in December, 1950); phosphate applied 16th September, 1953 (also in 1946, 1947 and December, 1950); nitrogen applied 25th February, 1954 (annually).

Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. Planted 8th December, 1953.

YEAR OF APPLICATION

Mean Yields: Seed Cotton in lb. per acre.

	(1)	d	n	nd
p_0	674	1,204	696	1,140
p_1	882	1,240	1,109	1,260
p_2	1,008	1,314	1,091	1,305
Sign. Diff. (P=·05)—				
in the same half of table ...			140	
in different halves ...			196	

Main effects:

n_0 ...	1,054	... p_0 ...	929	... d_0 ...	910
n_1 ...	1,100	... p_1 ...	1,123	... d_1 ...	1,244
		p_2 ...	1,179		
S.E. ...	±29·6	...	±24·6		±20·1

Interactions:

	NP_2 +29	... P_2D ...	—113	... ND ...	— 64
S.E. ...	±34·8	...	±34·8	...	±28·4

The results of Trial (26) are given in Table 4. Here the compost and phosphate figures are first residual responses; they follow more or less the usual course, but again this season the nitrogen responses are very small.

TABLE 4.—NPD EXPERIMENT

Ukiriguru—Hill Sand—Trial (26)

Five replications of 2×2 factorial, with split plots of 1/69·7 acre giving four nitrogen treatments. Compost and phosphate applied 29th November, 1952; sulphate of ammonia applied 20th November, 1953, at planting, and 10th February, 1954, at flowering (also in the 1952/53 season).

Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. Planted 20th November, 1953.

p_0, ... p_1 ... 0, 150 lb. triple supers per acre.
d_0 ... d_1 ... 0, 6 tons compost per acre.
n ... 175 lb. sulphate of ammonia per acre in 1953 and 1954.

FIRST RESIDUAL YEAR—NITROGEN REAPPLIED

Mean Yields: Seed Cotton in lb. per acre.

Nitrogen Treatments	Second indicator crops—compost and phosphate				Nitrogen Means
	(1)	d	p	pd	
No Nitrogen	579	774	796	929	771
At planting	630	807	942	915	824
At flowering	568	861	936	901	817
1952/53 residual	606	909	870	971	840
Sign. Diff. (P=·05)					
in the same column			135		68
in different columns			159		S.E.±23·8
P and D means	596	839	887	930	
Sign. Diff.			95		

Main effects: P +191
D +143 S.E. ±31·0
PD —100

As last year, there were Lake Province Cotton Committee tests in the Mwanza-Bukumbi-Urima Chiefdoms, "over the fence" from Ukiriguru, testing in African holdings dressings of 90 lb. of double superphosphate/acre, with and without a top dressing of 200 lb./acre sulphate of ammonia. Control yields were lower than last season, but responses to phosphate were very similar—an increase of over 140 lb. seed cotton/acre. The nitrogen responses were better than at Ukiriguru, possibly due to scattered March showers;but considering that any nitrogen response is for the year of application only, the use of sulphate of ammonia

cannot be recommended to the local cultivators. Phosphate manuring in these hill sand areas is entirely different. Results over the years are such that the encouragement of phosphate manuring for cotton in these areas is now fully justified.

The co-operative movement in the Lake Province has displayed interest in the possible use of fertilizers, and it seems probable that the sale of phosphate to members will be organized. It must be remembered, however, that while the use of phosphate should be encouraged to the full in these areas, organic manure is the more valuable dressing.

Spacing.—Superimposed in the Time-of-Planting Trial, already referred to, were various spacings, plus comparisons of top dressed nitrogen, and no nitrogen. The time of planting results have already been discussed. The nitrogen responses were nil. There were two rows per ridge, and two plants were left per hill. The spacings were 9 inches, 12 inches, 18 inches and 36 inches in the row. Final stands varied around 70 per cent. There were no significant yield differences. This adds support to the general view that with reasonable spacing there can be a fair loss of stand, e.g. from termite damage, without drop in yield.

In the seed dusting trial, discussed later, it is shown that reduction in stand caused by bacterial blight was not a factor in reducing yield.

Ridge Tying.—The results from the main Ukiriguru ridge-tying trial are set out below.

	Seed cotton lb./acre	Bulrush millet grain lb./acre
Poor ridges not tied	777	719
Good ridges tied	941	798
Sign. Diff. (P=·05)	89	Not sign
S.E.	±27·8	±35·4

The difference in the reactions to treatment of the two crops—cotton and bulrush millet—is again seen. There was promise, in the cotton portion of the trial, of even larger profit from tying, until the March drought affected the lusher growth in the tied plots.

At Lubaga, where the soil is shallow and water conservation is of major importance, tie-ridging is the most important factor in increasing yield. The "ibushi" ridging trial—Table 5—shows that this operation gave increases up to 400 lb./acre seed cotton, compared to flat cultivation. This trial is being extended to measure the effect of the treatments each year on both cotton and sorghum yields.

On the "ibambasi", cemented hard soil, at Lubaga, the tie-ridged plots considerably outyielded flat cultivation, but the results were not statistically significant.

TABLE 5.—RIDGING TRIAL

Lubaga "Ibushi" Soil

Six blocks of five plots of 1/29·0 acre. One row per ridge: spacing twelve inches in three-foot rows, seven inches in five-foot rows. Planted 4th November, 1953.

Treatments	Seed Cotton lb./acre	
Flat cultivation—3-foot rows	491	100%
3-foot ridges—not tied	631	128
3-foot ridges—tied	915	186
5-foot ridges—not tied	524	107
5-foot ridges—tied	725	148
Sign. Diff. (P=·05)	106	22%
S.E.	±35·8	

Rotation.—There were again no significant differences in the Ukiriguru rotation trial, where continuously planted cotton and continuously planted bulrush millet are compared with, simple rotation, 1 : 2 rotation, and 2 : 2 rotation.

A similar trial at Lubaga with Dobbs sorghum as the grain crop, now in its fifth year, showed a small increase in cotton yields in the longer rotations.

Weeding.—In observation plots, not replicated, various standards of weeding were compared. Serious delay in weeding resulted in a half crop.

COTTON BREEDING

UK. 48 in 1953-54 covered most of the Province, except for UK. 46 in the Shinyanga zone, UK. 51 multiplication in part of the Buchosa zone, and UK. 53 multiplication in part of Kome Island. UK. 51 has given an excellent multiplication rate. From just over 1 ton issued for first multiplication in 1951/52, it is reported (R.A.D.A., Mwanza) that at the end of the third season of growing, there were 2,480 tons of seed for planting.

In yielding capacity UK. 48 and UK. 51 seem to be very similar, with UK. 46 poorer; all are a marked improvement on MZ. 561. From the Shirley Institute spinning reports UK. 51 would appear slightly better in spinning qualities and yarn appearance. UK. 53 has given no improvement in yield over UK. 48 and UK. 51, nor as was hoped, do the spinning qualities show improvement. The multiplication on Kome Island continues, but it may well be that UK. 53 multiplication will not proceed further.

There were three strain trials at Ukiriguru—one 49 strain balanced lattice on hill sand, a similar trial in the valley bottom "mbuga", and a "poor land" 25 strain balanced lattice trial of the newer material. In the main hill sand trial there was heavy loss from termites. In the results given, only 3 replications where final stands were reasonable, have been used. In the "mbuga" trial there was severe Lygus attack on the regrowth after the break of the March drought; practically no top crop was set; there was only a very small July picking and no August picking. (This is in contrast to the main hill trial where one quarter to one half of the total crop was picked in August). The "mbuga" results are therefore from a crop arrested in development. Further, all these Ukiriguru results have to be reviewed in the light of the drought.

The Lubaga trial, again a 49 strain balanced lattice, was a very accurate one.

The district plot trials were 16 strain balanced lattices, the cropping results from nine of which, the more uniform and the more accurate, are shown in Tables (6) and (7).

TABLE 6.—1954 STRAIN TRIALS

Lint Yields in Pounds per Acre

Strain	Ukiriguru			Lubaga	Main Trials	District Plots									D. Plots
	Hill Sand Trial	"Mbuga" Trial	Poor land trial Exhausted Hill Sand	Ibushi Soil	Average as % of MZ. 561	Ukerewe		Geita		Nassa	Kwimba	Maswa		Shinyanga	Average as % of MZ. 561
						Buhima	Ragata	Arugongo	Ibondo	Shigala	Mabuki	Somanda	Lalago	Butulwa	
MZ. 561	269	336	—	245	100%	256	632	601	227	324	210	330	137	194	100%
UK. 46	313	355	—	350	120	294	673	675	272	308	280	438	207	296	118
UK. 48	375	380	203	394	135	323	686	731	284	351	290	486	225	270	125
UK. 51	324	379	203	436	134	336	670	677	288	328	303	421	200	280	120
UK. 53	380	369	221	406	137	337	597	715	269	306	275	507	230	270	120
Sign. Diff. (P=·05)	77	49	37	36		52	109	76	47	43	49	89	47	48	
S.E.±	27·6	17·5	13·1	13·0		18·2	38·3	26·6	16·7	14·9	17·1	3·11	16·6	16·7	

It is difficult to give any accurate assessment of the general profit to the Province due to the Ukiriguru seed issues; but the profit outlined below may be considered a fair indication of the increase potential from the strain issues, given attention to timely planting and reasonable agronomic improvement. In the 19 strain trials where MZ. 561 was compared with UK. 48—16 district plot trials, and 3 main trials, 2 at Ukiriguru and 1 at Lubaga—the mean yield increase of UK. 48 compared to MZ. 561 was *71 lb. lint per acre.* (An average increase of 2 lb. lint per acre on this last season's acreage would have been equivalent to just over 1,000 bales addition to the Provincial crop). Had the yields from these trials been a true reflection of the Provincial yields the increase from the growing of UK. 48 this last season, instead of MZ. 561, would have represented over 38,000 bales—with a baleage value of somewhere around £2,000,000. (But the Provincial mean yield was 168 lb. lint per acre, compared to 343 lb. lint per acre for UK. 48 in the 19 trials). The strain trials covered a range of areas and conditions, and in the district plots were cultivated by plot holders.

In Table 6 it will be seen that in the main trials last season UK. 48 and UK. 51 averaged somewhere around a 35 per cent increase (lint) on MZ. 561. In the "mbuga" arrested trial the increase was only just over 11 per cent; in the hill sand trial the increase was about 30 per cent, and at Lubaga nearly 70 per cent. The value of the seed issues seems to be the greater inland from Ukiriguru, and where growing conditions are poorer.

In Table 7 are set out for Ukiriguru, Lubaga and district plots, the cropping results of some of the more important Ukiriguru strains, against the means of UK. 48/UK. 51. It will be seen that the better 5/57 and 6/318 strains yielded around the UK. 48/UK 51 level. Strains in the important 8/290 group out-cropped UK. 48/UK. 51; the most important is 0/334, followed by 1/667. In the main trials 0/334 is 19 per cent up (lint), and for the nine district plot trials 11 per cent up. The high yielding of 1/686, a survivor of the Barberton Sea Island × U. 4 materials, is interesting. 0/334 and 1/667 in spinning tests gave quite good yarn strength and fair yarn appearance. It is hoped to constitute a UK. 55 in which these two strains very probably will feature.

TABLE 7.—1954 STRAIN TRIALS

Lint Yields in Pounds per Acre

Group	Strain	Ukiriguru			Lubaga	Main Trials	District Plots								D. Plots
		Hill Sand Trial	"Mbuga" Trial	Poor land trial Exhausted Hill sand	Ibushi Soil	Average as % of UK. 48/51	Ukerewe		Geita		Nassa	Kwimba	Maswa		Shinyanga	Average as % of UK 48/51
							Buhima	Ragata	Arugongo	Ibondo	Shigala	Mabuki	Somanda	Lalago	Butulwa	
Controls ...	UK. 48) UK. 51)	349	380	203	415	100%	330	678	704	286	340	296	454	213	275	100%
ex 5/57	0/89	392	333		430	101	272	694	713	257	338	279	446	227	263	97
	0/95	411	340		362	97	315	640	756	316	323	270	462	228	297	101
ex 7/150 ...	0/282	381	318		435	99	263	674	734	270	324	290	499	206	299	99
	0/285	343	261		373	85	290	495	717	239	275	283	335	177	263	86
	1/613	409	267	169	346	89										
ex 6/318 ...	8/95	413	343		374	99										
	8/151	388	373		378	100										
ex 8/290 ...	8/290	418	368		417	105										
	0/331	364	452		411	107	386	621	746	309	330	332	430	219	235	101
	0/334	461	427		472	119	350	719	742	321	309	333	499	312	276	111
	1/667	406	400	208	465	110										
ex 7/367 ...	0/457	353	360		425	99										
	0/460	380	299		377	92										
Sea Island × U.4	1/686	397	380	227	451	108										
Sign Diff. (P=·05)		77	49	37	36		52	109	76	47	43	49	89	47	48	
S.E. ±		27·6	17·5	13·1	13·0		18·2	38·3	26·6	16·7	14·9	17·1	31·1	16·6	16·7	

Ginning Percentage.—In Table 8 are shown the ginning percentages (optimum at Ukiriguru on a hand gin) for a range of strains covering a range of localities. The level, compared with the results shown in Fig. 3 of the 1952/53 report, is markedly the lowest in the past five seasons. The average ginning percentage of the same five strains in different localities shows a range of 1·5 per cent.

TABLE 8.—1954 STRAIN TRIALS

Lint and Seed Characters

Locality \ Strain	MZ. 561	UK. 48	0/95 5/57 group	0/285 7/150 group	0/334 8/290 group	Mean
Ginning Percentage:						
Ukiriguru	31·2	32·8	34·8	32·4	33·1	32·9
Lubaga...	31·5	32·4	33·5	34·3	33·7	33·1
Ragata	31·0	32·2	34·5	33·2	32·2	32·6
Arugongo	31·5	32·9	34·5	34·1	33·0	33·3
Mabuki	32·0	33·5	35·2	35·0	34·0	33·9
Somanda	31·8	34·5	36·3	34·3	33·8	34·1
*Lagana	31·5	32·6	33·0	34·2	35·0	33·3
Mean	31·5	33·0	34·5	33·9	33·5	
S.E.			±0·26			±0·31
Lint Length: (*Seed Cotton halo length in mm.*)						
Ukiriguru	31·0	31·7	31·3	30·1	32·0	31·2
Lubaga...	31·4	30·4	33·3	—	33·1	32·0
Ragata	28·3	32·6	32·1	31·2	31·6	31·2
Arugongo	31·6	33·3	30·8	33·0	29·8	31·7
Mabuki	31·9	33·4	32·6	32·7	31·1	32·3
Somanda	30·9	34·1	32·1	32·1	31·9	32·2
*Lagana	26·7	29·7	26·8	29·1	30·0	28·5
Mean	30·3	32·2	31·3	31·4	31·4	
S.E.			±0·45			±0·53
Per cent Seed Coat Chalazal Damage:						
Ukiriguru	22	25	20	45	32	29
Lubaga	22	20	21	46	26	27
Ragata	6	11	7	26	12	12
Arugongo	14	25	16	47	22	25
Mabuki	8	15	14	18	14	14
Somanda	10	19	14	30	10	17
*Lagana	18	17	18	27	17	19
Mean	14	19	16	34	19	
S.E.			±1·7			±2·0

*Lagana, Shinyanga District, on "ibushi" soil, very badly droughted, was the poorest yielding district plot.

Lint Length.—The lint length variations shown in Table 8 illustrate the view that there are considerable lint quality variations within the Province. Lint from poorer growing conditions, and from Shinyanga areas, is very often shorter than from easier areas with better growth. This is strikingly demonstrated by the Lagana (Shinyanga District) measurements; growing conditions at the Lagana District plot were especially difficult and yields very poor.

Seed Coat Damage.—Also in Table 8 are set out the percentages of seed coat chalazal damage. This is now to become a routine assessment at Ukiriguru. It will be seen that there are differences between strains and again considerable locality variations. 7/150 strains are amongst the worst; the worst representatives gave figures in the Ukiriguru "poor land" trial up to 60 per cent damaged seed; but it is interesting to note that these same strains in earlier spinning tests were

above the average in yarn appearance grading. There is segregation in 7/150 for this seed coat damage. Again this season the 7/150 strains have been disappointing in their cropping, Table 7.

The visit of Mr. Underwood of the Shirley Institute with Mr. Evenson of Namulonge was much appreciated, and the opportunity that it gave for discussing Shirley Institute and Namulonge assessments of cotton quality.

Crossing Programme, Ukiriguru strains × Albar 51.—This continues to be the most important part of the breeding programme. In-season the main work was backcrossing from B_2 to B_3. Out-of-season the main work was selfing the best of the B_3 single plant selections. Selections from this B_3 selfed material are to be planted as single plant lines this 1954/55 season. As an insurance, the main lots are to be carried to B_1 in 1954-55. In 1952 and 1953 in-season material, up to the B_2 stage, there has been a fair proportion of "wilter unbalanced" types. In the out-of-season B_3 single plant lines, kept watered, only one suspect "wilter" was observed. In B_1 material being backcrossed out-of-season to B_2, four "wilters" were observed in one lot.

All seed was treated with *Xanthomonas* suspension, and plants were later needle-prick inoculated. Susceptible plants were rogued out.

A start has been made with the adding of B_{6m} to the best of the Ukiriguru lots. Seed of BAR 14/38 (B_2B_{6m} Sakel) was obtained from Shambat. This is gratefully acknowledged. F_1 material will be planted when ready, in-season 1955, for first backcrossing.

DISEASES AND PESTS

Diseases

Bacterial Blight (*Xanthomonas malvacearum*).—In two previous seasons the effectiveness of seed treatment in reducing the incidence of seedling infection has been demonstrated. Information on the influence of seed treatment on yield has been inconclusive, trials being complicated by the occurrence of later infection arising either from trash or by spread from plot to plot.

During the past season, seed treatment trials were laid down in which each plot was separated from its neighbours by a distance of not less than 20 feet. The intervening spaces were planted with bulrush millet and velvet beans.

Trial "A" was laid down in a field which had not carried cotton for at least five seasons and in this trials the mean increase in yield due to seed treatment was 177 lb./acre of seed cotton or 25 per cent. Seed treatment did not influence the proportion of stained (Grade "C") seed cotton. In addition to the occurrence of bacterial boll rot, stainers (*Dysdercus* spp.) were also present, and a detailed assessment of the relative importance of these two agencies in the production of stained seed cotton, was not attempted.

Details of the yields and stands are shown in Table 9 together with an indication of the incidence of bacterial blight at the seedling stage.

TABLE 9.—SEED TREATMENT TRIAL "A"

Njihiji III.—Good Rotated Land

Eight blocks of five plots each 1/48·4 acre. Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. (Complete stand=11,616 per acre). Planted 2nd December, 1953. Refilled 17th December, 1953 and 15th January, 1955.

Treatments	Yield of seed cotton		Final stand per cent complete stand	Percentage of seedlings affected by bacterial blight at 44-46 days	
	lb./acre	Grade "C" per cent		True-leaf lesions	Main-stem lesions
Untreated	703 = 100%	17·5	53·4	95·5	52·3
Sulphuric acid	859 = 122%	17·4	60·2	11·7	2·4
Perenox 1:300 w/w ...	897 = 128%	20·2	66·8	51·5	5·0
Agrosan G.N.5 1:300 w/w	920 = 131%	15·9	68·6	4·7	nil
Spergon 1:300 w/w ...	845 = 120%	17·8	61·9	17·8	0·5
S.E.	±35	±1·3	±2·7	Average number of seedlings scored per treatment = 223.	
L.S.D. (P=·05)	101 = 14%	Not sign.	7·9		

From the figures shown in this table there appears to be a relationship between yield and stand, but a regression of yield on stand could not be established. Loss of stand was caused both by bacterial blight and by the activity of termites. Plots with low stands which were grown from treated seed did not in general show depressed yields and it would appear that under the conditions of the trial, loss of stand was not of itself sufficient to account for the observed loss of yield in the untreated plots. This is illustrated by the data shown in Table 10 from which it can be seen that block yields are not related to stands, although the range of block stands is comparable with that for treatments.

TABLE 10.—SEED TREATMENT TRIAL "A"

Block Yields and Stands

Blocks	I	II	III	IV	V	VI	VII	VIII	S.E.	Mean
Yield Seed Cotton lb./acre ...	866	837	806	871	850	842	816	845	±44	842
Final Stand per cent Complete Stand...	67·5	72·1	66·8	61·8	52·1	53·8	57·8	65·6	±3·5	62·2

Trial "B" was planted in a field of markedly low fertility where cotton had been grown for the previous four seasons and had suffered moderate to severe attacks of bacterial blight. Under these conditions, the early attack of the disease was very severe, and numerous seedlings in the untreated plots were killed. With the drought, however, the progress of the disease was arrested, and the new growth following the April rains was largely free from serious bacterial blight.

As the season progressed, pronounced fertility irregularities appeared in this trial and of ten replications laid down four, covering the area worst affected by these irregularities, were rejected. The analysis, based on the remaining six replications, showed a mean increase in yield due to seed treatment of 126 lb./acre of seed cotton or 29 per cent. Detailed results are shown in Table 11. The regression of yield on stand was not significant.

TABLE 11.—SEED TREATMENT TRIAL "B"

Nyashimba VA.—Poor Trash-Infested Land

Six blocks of three plots each 1/69·7 acre. Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. (Complete stand=11,848 per acre). Planted 1st December, 1953. Refilled 16th December, 1953.

Treatments	Yield of Seed Cotton		Final stand per cent complete stand	Percentage of seedlings affected by bacterial blight at 48-50 days	
	Total lb./acre	Grade "C" per cent		True-leaf lesions	Main-stem lesions
Untreated	441 = 100%	17·2	43·0	100	51·9
Sulphuric acid	516 = 117%	16·6	60·4	87·2	2·9
Perenox	618 = 140%	16·8	64·3	95·8	9·1
S.E.	±44	±1·1	±2·8	Average number of seedlings scored per treatment = 359.	
L.S.D. (P=·05)	135 = 31%	Not sign.	8·8		

Information obtained during the season on the occurrence of trash infection was inconclusive. The results of seedling scores in trials "A" and "B" (Tables 10 and 11) indicate a higher incidence of leaf infection in the seedlings grown from treated seed on the poor trash infested land in trial "B" although the seed used in both trials was from the same bulk. It may be that the additional infection in trial "B" arose from trash, but it has frequently been observed that bacterial blight becomes established more readily on cotton growing under conditions of poorer fertility and these two factors are confounded in the trials. Moreover other factors governing the establishment of the disease may not have been similar in the two trials, and the seedlings in trial "B" were 2-6 days older when scored.

In a third trial planted on land which had been under grass rest for four years, trash was applied to half the plots. The trash, which was known to be heavily infested with *Xanthomonas*, was applied in the furrows before ridging at the rate of 700 lb./acre (air-dry trash). (Half the plots were planted with acid treated seed and half with untreated seed, giving a 2×2 factorial set of treatments).

A seedling score at six weeks after emergence showed that there was no increase in the incidence of seedlings showing leaf or stem lesions in the trash-treated plots, and the yield data showed that trash applied in this manner had no influence on yield. (The mean increase due to seed treatment in this trial was 99 lb./acre of seed cotton, an increase of 8 per cent on the mean yield for untreated seed which was 1,230 lb./acre).

The results of these trials show that seed treatment gave a worthwhile increase in yield on both rotated and trash infested land, and indicate that under the particular conditions of this season, seed borne infection was more important than infection arising from trash.

Attempts to assess the benefit from seed treatment with Perenox under conditions of native cultivation gave inconclusive results. There was a general impression of a less severe attack of bacterial blight in those areas planted with treated seed, but this was not conclusively reflected in scores of the incidence of plants with stem lesions (at 2-4 months old) recorded in treated and untreated areas. Yields were recorded by staff of the Department of Agriculture from plots on either side of the seed treatment "boundary". The results were very variable and did not show a significant increase in yield due to seed treatment.

Last year some 2,200 tons of seed were treated with Perenox, this being enough to plant nearly half the Provincial crop. In the current year, 4,700 tons have been treated, enough for the whole crop.

Wilt—Fusarium oxysporum f. vasinfectum.—In March some wilted plants, similar to those observed in previous seasons at Lubaga, were discovered in a group of native holdings on Lake-shore sand in Geita District, where UK. 48 was being grown. Affected plants occurred singly or in patches of up to 30 yards in diameter, over an area of about a quarter of a square mile. As observed previously at Lubaga there was no apparent association between the occurrence of the disease and continuous cropping with cotton. Much of the cotton, in which affected plants were observed, was growing on land which had carried cassava in the previous season and some was following "tumbledown" fallow. In a few holdings, however, there had been no rotation. The wilt symptoms were severe and in many cases the plants had died. In all cases there was staining of the vascular tissue.

Laboratory examination of affected plants revealed fungal hyphae in the xylem and a *Fusarium* sp. was isolated from vascular tissue from both stem and roots.

Specimens were sent to the Senior Plant Pathologist, Dr. G. B. Wallace, who also isolated a *Fusarium* sp. and showed it to be pathogenic to UK. 48. The pathogen was confirmed as *F. oxysporum f. vasinfectum* by Dr. W. L. Gordon in Winnipeg.

Pests

Taking the Province as a whole loss due to insect pests was light, though there were the exceptions.

American Bollworm.—In part of the Musoma District there was American bollworm loss, starting in June extending into July—associated with plantings of maize and chick-pea; later there was Lygus damage to the sappy new top growth. Quite considerable total loss was caused in the area. The percentage of Grade C. bought in the Musoma zone was exceptionally high for this year compared with other zones.

At Ukiriguru the nice balance was again demonstrated between American bollworm egg-laying on a range of host crops, of which cotton is but one.

In March the Botanist reported American bollworms in close-panicled sorghum heads, from 20 up to more than 100 per 100 heads. There were many fewer in the more open-panicled heads. In early May in open-headed types, no American bollworms were found in unbagged heads in the breeding plots, but in around 25 per cent of the bagged heads bollworms were found. These results, and other reports, would seem to indicate predator or bird attack on the bollworms in the more easily attacked open-panicled heads.

This aspect of the extension of the growing of close-panicled early maturing sorghums generally in the cotton growing areas requires consideration, involving, as it may, possible foci of American bollworm build-up.

At Ukiriguru there were plantings of trap-crop maize at intervals, to give American bollworm egg-laying cover to the cotton. Tasseling maize in May, June, and July, carried larval populations of the order of 40 to over 100 per 100 maize plants. Maize planted before mid-February was all cut while carrying larvae, and used for ensilage. The station bulk maize was planted after mid-February.

In spite of the considerable American bollworm moth populations that must have been present in the Ukiriguru area in the main period of cotton flowering, American bollworm attack on cotton was quite unimportant. The other host crops had kept the egg-laying off cotton.

Spiny Bollworm.—There were reports of some spiny bollworm loss throughout the Province. At Lubaga in mid-March 1,000 per acre were recorded in one count.

Pink Bollworm.—Very occasional pink bollworms were reported in the Lake shore area. At Ukiriguru in-season, none was observed; but in the out-of-season crossing plot (half an acre) considerable numbers were observed from late October. Affected bolls were picked off and buried.

Lygus.—Reference has been made to Lygus damage to the late top growth in parts of Musoma District, developing in the top growth after the the May rains, and following American bollworm damage. (Such Lygus development tallies with the reports of what is happening in the South Nyanza Province of Kenya).

There was serious Lygus damage in the Ukiriguru valley bottom "mbuga", where cotton was grown adjacent to plots of early maturing sorghums. The "mbuga" cotton had been badly checked by the March drought. In late April/May there was a sappy top regrowth. Starting in late April through into June, there was very severe Lygus attack. As a result the July picking was negligible, and there was nothing at all to pick in August. (Contrasted with this, the hill sand trial gave from one quarter to one half of the total crop in the August picking). The assumption is that the "mbuga" attack was a transference of Lygus populations from the ripened sorghum plantings to the sappy cotton top-growth.

On another area of the station, early maturing sorghum types, comparatively late planted, were growing adjacent to cotton; the sorghums carried through a big Lygus population; but there was no noticeable loss on the adjacent cotton.

Jassid.—In the 1951/52 Report it was stated that, with the distribution of the new Ukiriguru strains, it was hoped that jassid would no longer be a major factor liable to affect the Lake Province cotton crop. In 1952/53 jassid was quite unimportant. But this last season has shown that there must be no relaxation in the task of getting as high a degree of jassid resistance as possible.

Quite early in the season there was noticeable jassid damage on UK. 48 in poorer kept "holdings". In the new growth in April after the drought check, there was at first poor leaf hair expression, and there was jassid damage; but, especially in the better grown cotton, leaves developed adequate hairiness and the plants quickly grew away from any jassid expression. The importance of the observation lies in the need for maintaining as high a degree of jassid resistance as possible in any seed issue.

Stainers.—In the South-West areas of the Province, for example Lubaga, where stainers can be a serious menace, this season the damage was light. Population counts at Lubaga were low, never as much as 1,000 to the acre. Routine stainer poisoning was carried out. A trial of the standard arsenic-blob treatment was laid down. Unfortunately it was planted late; no results were obtained.

In the Nassa, Musoma, and Ukerewe mainland areas, where normally stainer damage is low, stainer populations were exceptionally high.

In the out-of-season crossing plot at Ukiriguru, in November/December stainer populations—*D. superstitiousus*, *D. nigrofasciatus*, and *D. fasciatus*—were high, causing heavy boll infection.

At Ukiriguru the percentage of Grade C. was around 15 per cent at Lubaga exceptionally low, 12 per cent in the district plots it varied from as low as 7 per cent. with most of the plots 10 per cent to 20 per cent, up to 59 per cent at Lalago, South-West Maswa.

Termites.—Termites reduced stands considerably in some areas.

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Ukiriguru

APPENDIX

ORIGIN AND SPECIAL CHARACTERISTICS OF THE MAIN COTTON STRAINS MENTIONED

Lake Province "Local"	The commercial cotton in the Province prior to the issue of MZ. 561—mainly of Uganda Local origin.
MZ. 561	A straight selection from "Local", first multiplied in the 1939-40 season.
UK. 46	A seed issue with fair jassid resistance, made up of the four best Ukiriguru strains and the three best Lubaga strains available at the time, first multiplied in the 1946-47 season.
UK. 48	A seed issue made up of four strains of better jassid resistance than UK. 46 first multiplied in the 1948-49 season.
UK. 51	A seed issue made up of seven strains with jassid resistance, first multiplied in the 1951-52 season.
UK. 53	A seed issue made up of eleven strains, first multiplied in the 1953-54 season.
5/57	A derivative of 3/17, itself a straight selection from "Local".
6/318	Ex 4/35, itself a derivative of MZ. 561.
7/150	Ex 3/28, having high jassid resistance.
7/367	Ex Lubaga L. 4/112, ex originally Mz. 457.
8/290	Ex 6/320, one of the heaviest cropping Ukiriguru strains.
1/686	Ex Barberton U. 4 × Sea Island.
Albar 51	General term for 1951 selections from Nigerian Allen, highly resistant to bacterial blight; ex Dr. J. B. Hutchinson.

SOIL CHEMISTRY STUDIES AT UKIRIGURU

A start was made in 1954 with laboratory studies of some of the soil fertility problems at Ukiriguru. Two visits each of a month were made to Ukiriguru in February and May, 1954. Progress will be slow so long as the work has to be done during visits from Namulonge. A Makerere graduate in Chemistry will be appointed to work at Ukiriguru as soon as a suitable man can be found. At present (September, 1954) it seems unlikely that there will be anyone available before the end of 1955.

The work is directed towards the elucidation of the results obtained in field experiments over the past ten years. In particular we wish to know what are the operative factors in the long term effects of land resting and organic manures.

Evidence from field experiments suggests that phosphate is primarily responsible for these effects. In addition sulphate of ammonia has been shown to increase yields, particularly when phosphorus is also given. The nitrogen status of the soils will be studied and the possibility of sulphur being effective in sulphate of ammonia will be borne in mind.

In time we hope to make a study of the crop-soil-water relationships at Ukiriguru. The superiority of tied ridges over untied ridges in increasing crop yields has been demonstrated in the field. This effect is undoubtedly due to water conservation but we have no knowledge of the amounts of water involved.

Work so far has been concerned with the nitrate status of the soil. Nitrate determinations were made in May on soils from two experiments under cotton in which compost (C) at 6 tons per acre, triple superphosphate (P) at 150 lb. per acre and sulphate of ammonia (N) at 175 lb. and 250 lb. per acre were being tested. In one experiment, Nyashimba, Trial (26), the compost and phosphate were applied to the 1952-53 crop, and in the other experiment, Ngereja, Trial (9), these treatments were applied to the 1953-54 crop. In each experiment sulphate of ammonia was applied as a top dressing to the crop in 1954.

At the time of sampling the plants were flowering freely and many bolls had been set. Samples were taken in units of 6 inches. In Trial (9) six samples between 0 and 60 inches were taken, alternate samples below 12 inches being rejected. Mean values (in ppm NO_3-N in air dry soil) of the six depth samples from each treatment are presented below.

I.—Trial (26), mean of 6 samples, 0-36", NO_3-N, ppm in air dry soil

	–	P	C	CP
–	0·9	0·8	0·7	0·7
N	11·1	2·8	6·3	2·8

II.—Trial (9), mean of 6 samples, 0-60", NO_3-N, ppm in air dry soil

	—	P	C	CP
—	0·8	0·5	0·4	0·5
N	3·7	2·3	2·5	1·2

The figures presented show how the presence of both phosphate and compost increase the plants' demand for nitrate as indicated by a reduction in the soil nitrate status. There appears to be a limit of about $\frac{1}{2}$ ppm N below which the plant cannot remove nitrate from the soil, and that in the absence of phosphate or compost the added nitrogen was in excess of the plants' requirements. At Namulonge similar results have been obtained but the soil nitrate values are generally higher than at Ukiriguru.

In Trial (26) plots which had received sulphate of ammonia in 1953 were analyzed. These were found to contain no more nitrate than plots which had received no sulphate of ammonia. This supports the results of field experiments which generally show no residual effect of sulphate of ammonia.

pH determinations on samples from Trial (26) showed a drop from 6·0 to 5·5 in the 0-6-inch layer due to the addition of sulphate of ammonia. There was no effect in the 24-30-inch layer. Plots which had received sulphate of ammonia in the previous year gave a pH of 6·0 suggesting that the acidifying effects of sulphate of ammonia are temporary.

In Trial (9) the reduction in pH due to sulphate of ammonia was from 6·4 to 5·6 in the surface, and from 6·5 to 6·0 at 60 inches.

P. H. LE MARE

ILONGA AGRICULTURAL STATION

PROGRESS REPORT OF THE SEASON 1954

COTTON SEASON

Planting:
February to April.

Picking:
July to November.

Legal Uprooting dates:
Kilosa District—30th November.
Bagamoyo District—30th November.
Kisarawe District—30th November.
Ulanga District—15th December.
Morogoro District (Duthumi)—15th December.
Morogoro District (except Duthumi)—30th November.
Rufiji District—30th December.

Rainfall:
November, 1953 to October, 1954: 38·11 inches.

INTRODUCTION

Ilonga Station

Meteorology.—Rainfall was up to average but fell mainly in January, February and March. In April and May only light showers occurred. Cotton followed a December-planted millet crop, *Panicum milliaceum* (harvested in March) and this probably affected cotton yields, as it is doubtful if there is sufficient soil moisture available to harvest two good crops a year.

Staff

Mr. R. Smith arrived in February on transfer from Nyasaland. Mr. E. W. Valentine went on vacation leave in November. Work has carried on with co-operation from members of Colonial Agricultural Insecticide Research Unit and the Agricultural Department staff.

Visitors

Ilonga has been visited by Mr. J. C. May, Sir Geoffrey Clay, Mr. J. E. Peat and members of the Department of Agriculture during the past year; the Eastern Province Cotton Committee held a meeting and were shown the effects of insecticide applications and better cultivation. Two parties of native cultivators also visited the station and it is hoped that this will become a regular part of the station's activities.

Eastern Province Cotton

Cotton growing areas in Eastern Province are diffuse and tend to be situated in isolated blocks mainly due to the geography of the province. Consequently, each area needs to be treated on its merits. District plots with one or two cultivation trials, a variety trial and investigations on the pest problem in each area should provide the answers for localized conditions.

In general during the 1954 season much cotton was late planted due to the bad distribution of rain at planting time and late preparation of land. Pests (mainly American bollworm) were present but heavy attacks occurred only in

localized areas in most districts, the degree of attack probably being due to the amount of maize planted in an area and the pattern of crops and cultivation in time and space in that area.

Variety 47/10 was grown in the Mngazi and Kisaki areas of the Duthumi ginnery zone.

General Conclusions

It was shown during the season that insecticide applications were economically profitable on Ilonga when cotton was well tended and that the "Swaine" duster is the best gun to use under local conditions.

Early planted cotton (dusted and not dusted) gave, significantly, the best yields. The yields obtained from late planted (April) cotton did not cover the cost of insecticide, where this was used. Improved cultivation methods need encouragement in most districts of the Eastern Province before the use of insecticides, to control heavy bollworm attacks, can become an economic possibility. The entomologist's main line of enquiry in the coming season will be to assess crop losses due to pests in native grown cotton gardens. Also, he will attempt to estimate the possible profit from pest control, where gardens are planted at various times, where the efficiency of cultivation differs from plot holder to plot holder and where the system of agriculture has introduced other variants (e.g. previous cropping, interplanted cotton with maize, etc.).

There is considerable variation in yield, ginning percentage and lint length within cotton grown in the Eastern Province.

The season at Ilonga, on the whole, was a good one, despite the early cessation of rain in May. The later formed bolls dried up on the plant, probably due to lack of soil moisture, and no top crop was picked. All the cotton was dusted with 10 per cent DDT and 3 per cent BHC at approximately 8 lb. per acre; no excessive care was taken but control was good. The dusting resulted in a quick maturing crop, senescence occurring with rapid defoliation at the end of July. An area of non-dusted cotton kept its leaves and produced bolls and flowers until it was uprooted on 16th November. Fruiting was slower in this non-dusted cotton and none of the bolls formed during August and September produced any Grade I cotton; stainers, pink bollworm and drought were the main contributing factors it is believed, in stopping the formation of a late crop. The percentage of total cotton for each pick in the dusted and non dusted areas is shown in Table I.

TABLE I

AMOUNT OF COTTON HARVESTED AT EACH PICK, EXPRESSED AS PERCENTAGE OF THE TOTAL COTTON PICKED, FOR DUSTED AND NOT DUSTED COTTON

Pick:	1st	2nd	3rd	4th
Date:	4th August	18th August	4th September	10th November
Dusted:	67%	30%	3%	–
Not Dusted:	43%	39%	14%	4%

The 4th pick was all Grade III cotton.

Spacing—Time of Planting

February planted cotton gave a considerable increase in yield over all other treatments. Planting after the end of March gave a negligible yield. This applied equally to dusted and non-dusted cotton.

February planting enables the crop to flower during March and April when the rainfall expectation is the greatest and also allows time during the rains for refilling if this is necessary. An earlier crop can be picked and a longer closed season enforced, thus reducing pink bollworm populations and avoiding stainers.

In the native system of agriculture priority is given to food crops. The land is prepared in November and December and sorghum, millet, maize, etc., are planted as soon as sufficient rain falls in December or January. Land for cash crops (cotton, sunflower, etc.), is then opened up and prepared, and planted between February and the end of April; depending on the individual, the season, and the land he is cultivating.

In the case of the cotton grower, it would be better if he opened up and prepared all his land in December, before the food crop planting rains. Then, if rain comes early in February he could plant his cotton without any delay. If, however, he has to prepare his land for cotton in February and then no adequate planting rain falls until late March or April, his yields will be considerably reduced, whether bollworm is present or not.

The results indicate that a closer spacing than 3 feet × 3 feet with two plants per hole would give increased yields, especially when insecticides are used.

This trial was planted well away from maize and a relatively high yield was obtained from the early planted non-dusted treatment, in spite of the loss of the later crop from lack of soil moisture, stainers, and pink and spiny bollworm. Thus, good cultivation is equally as important as insecticide application. It is hoped that control of insects will encourage the better native farmers to improve their cultivation methods.

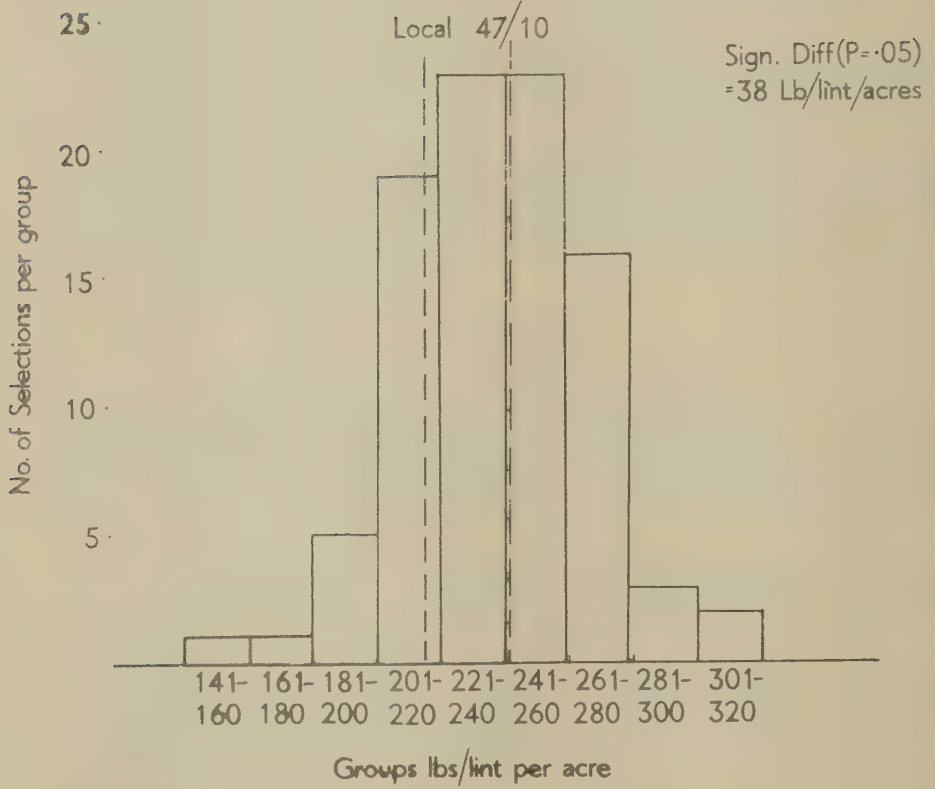
TABLE II

Spacing—Time of Planting

Two trials (one dusted with 10 per cent DDT and 3 per cent BHC weekly May and June) of six blocks each with eight treatments each, 1/203·3 acre per plot, 3-foot ridges, tied, spacing of control 3 feet × 3 feet with two plants per hole.

	Dusted		Not Dusted	
Treatments	Seed Cotton in lb. per acre	ABW/10 plants per week	Seed Cotton in lb. per acre	ABW/10 plants per week
March planted:				
Between plants 6″ plants per hole 1 ...	1,114	1·37	733	8·22
Between plants 12″ plants per hole 1 ...	1,125	1·26	663	3·78
Between plants 18″ plants per hole 1 ...	1,000	0·83	602	2·49
Between plants 36″ plants per hole 1 ...	669	1·26	566	2·52
Between plants 36″ plants per hole 2 ...	784	0·98	608	1·96
Between plants 36″ plants per hole 3 ...	917	1·31	657	1·31
February planted:				
Between plants 36″ plants per hole 2 ...	1,300	0·95	1,006	1·90
April planted:				
Between plants 36″ plants per hole 2 ...	28	0·72	42	1·44
Sign. Diff. (P=·05)	159		140	ABW= American bollworm
S.E.	±55		±49	

FIG. 3
VARIATION IN LINT YIELDS-ILONGA 1954
IN 51 SELECTIONS



(i) *Rain grown types.*—In Eastern Province the local strain is being replaced by 47/10, which, although of better quality, has a lower ginning out-turn. The general breeding programme at the moment is to obtain a strain with high yielding capacity and improved ginning out-turn that can still produce marketable lint under poorer growing conditions than Ilonga.

This past season the 116 strains selected at Ilonga prior to 1952 were tested in variety trials. The selections (23 strains) made before 1949 were also tested at four district plots, but yields from these were very disappointing.

From all these strains, thirty-nine 1951 selections were sent for spinning tests. Twelve of the pre 1949 selections from Ilonga and from each of the district plots were also sent. Of all strains, forty-eight will be put into trials again next year.

Two hundred 1953 selections were planted in small bulks. Thirty-five have been kept for trials next year.

Four hundred new selections have been made this season.

(ii) *Irrigation types.*—The possibility exists that a large irrigation scheme may develop in the Rufiji valley. It is hoped that a pilot scheme will start in 1956, to provide initial information.

For this, seed of a number of strains of Egyptian type cotton have been obtained from the Sudan and will be planted at Lupiro, in the Kilombero valley this coming season, to compare them against long staple Upland types from Eastern Province cotton.

Further, 250 selections have been taken from the present rain-grown crop, the only criterion being longer lint. It is hoped that some of these strains will eventually be tested in the Rufiji, and that a good strain will be available by the time the irrigation scheme starts, with lint qualities approaching the Sudan types.

Variation within the crop.—In all, this season, 1,676 single plant selections were made and each one was ginned and combed. The tables show the distribution of variation for these characters among these selections. (Tables III and IV).

The distribution of variation in yield in lint per acre is shown in Fig. 3 for the strains selected in 1951 and grown in variety trials at Ilonga. There is sufficient variation to provide better strains, with all requisite characters.

TABLE III

VARIATION OF LINT LENGTHS IN M.M. FOR STRAINS GINNING AT 29 PER CENT AND OVER IN 1954 SINGLE PLANT SELECTIONS

Lint length	Less than 32	32	33	34	35	36	37	38 and over
No. of Selections in each group	85	38	68	94	148	48	22	43

TABLE IV

VARIATION OF GINNING PERCENTAGES IN 1954 SINGLE PLANT SELECTIONS

Ginning per cent	Less than 28	28	29	30	31	32	33	34	35	36	37 and over
No. of selections in each group	315	236	309	320	207	139	77	40	22	6	5

Seed Coat Nep.—Counts of seed showing damaged chalazal tips indicate that although damaged seeds are present, the proportion is below twenty per cent for the majority of strains in most places. This character will have to be watched, though, especially as the proportion seems to vary considerably from place to place.

TABLE V

SEED COAT NEP. PERCENTAGE OF DAMAGED SEED

Strain	*Ilonga*	*Mvomero*	*Duthumi*
Local	3 ...	15 ...	33
47/10	4 ...	8 ...	8
45/12	6 ...	6 ...	22
45/4	15 ...	3 ...	13
48/36	3 ...	17 ...	25
48/67	2 ...	15 ...	12

APPENDIX I

ORIGIN OF COTTON STRAINS

Eastern Province Local ... The mixed commercial variety mainly of Uganda origin.

47/10 ... ... A 1947 selection with good quality lint but low ginning out-turn. It is being multiplied for distribution throughout Eastern Province to replace Eastern Province Local.

Entomology

This year the investigations into the control of cotton pests on Ilonga Research Station were conducted by officers of the Colonial Agricultural Insecticide Research Unit, while the Empire Cotton Growing Corporation entomologist co-operated in some of the trials by making observations on the insect populations, and also by carrying out some preliminary trials on the practicability of insecticidal control of pests in native grown cotton.

Acknowledgment is given to Mr. G. A. Jones, Chemist (C.A.I.R.U.) and Mr. K. S. McKinlay, Entomologist (E.A.A.F.R.O.), for information and the summary of results included in this report.

Insect Pests

American Bollworm (*Heliothis armigera*)

Field Sampling.—As in former years the first records of bollworm larvae were obtained from early planted and volunteer maize. Small numbers were recorded during January and February, but high numbers were not found until the beginning of March on January-planted maize.

Records taken during the period mid-March to early-July, on maize planted in mid-January, early-March and late-March, show that egg-laying continues for approximately three weeks after the first silks begin to open and that larvae can be found feeding on the silks and cobs, for five to six weeks taking the crop as a whole. In each successive crop the numbers of larvae recorded were lower, possibly due to the effect of control by parasites, and to the population becoming distributed over a wider area including attractive cotton as well as maize.

Eggs and larvae were recorded in cotton in mid-May, six weeks after planting. At the end of this month the population had reached approximately 1,500 larvae per acre, and there were 5,000 flared squares per acre, the point at which insecticide treatments were begun. During the next three weeks the populations in untreated plots rose rapidly to peaks of from 4,600 to 15,750 per acre, in different trials. Although the intensity of attack varied, the pattern was similar in each trial, beginning during May rising to a maximum in the third or fourth week of June and then declining to negligible numbers by the middle of July.

While numbers of larvae were decreasing in cotton during July, large populations were recorded on chick pea. This crop however was dusted so that the length and intensity of infestation could not be recorded.

Pupation Periods.—Bollworm larvae collected from the field were allowed to pupate in open bottomed tins set in the ground, in order to determine pupation periods under as natural a condition as possible. The records confirm the findings of previous years in that during the first five months of the year pupation periods rarely exceed 20 days, but that pupations beginning during June and July, when the minimum temperature falls to below 60°F, can last as long as three months.

The distribution of pupation periods is shown in the following table.

TABLE VI

DISTRIBUTION OF PUPATION PERIODS OF AMERICAN BOLLWORM 1954

Month of Pupation	Number of moths emgd.	Pupation periods in days							
		10–20	20–30	30–40	40–50	50–60	60–70	70–80	80–90
January ...	6	6	–	–	–	–	–	–	–
February ...	37	35	2	–	–	–	–	–	–
March ...	15	13	2	–	–	–	–	–	–
April ...	331	315	11	5	–	–	–	–	–
May ...	174	172	2	–	–	–	–	–	–
June ...	63	40	22	1	–	–	–	–	–
July ...	130	64	32	6	10	2	11	4	1

At the time of the last emergences, in October, no bollworm larvae could be found in cotton or other hosts at Ilonga, and a search of riverside maize, the most likely site of infection near Ilonga, did not reveal their presence. Many other known hosts including sunflower, pigeon pea, regenerated sorghum and *Tridax procumbens* were also searched intensively without success. Recording will be continued in an attempt to find those hosts on which bollworm is able to carry over from one season to the next, and to investigate the possibility of a much longer pupal diapause.

Spiny Bollworm (*Earias* spp.).—This pest was recorded in all trials sampled, from the first week of June, and remained at relatively low and variable numbers until late July when there was a rapid increase in both treated and untreated cotton. The numbers recorded did not show that one treatment gave better control than any other. The difficulty in assessing the effect of insecticidal treatment on *Earias* populations is that egg laying is dependent on the attractiveness of the plant. It seems that where American bollworm has been adequately controlled the state of the plant is such as to attract a greater number of adults than where plants have been heavily damaged.

Early in the season, before cotton became attractive, spiny bollworm larvae were recorded on both indigenous and cultivated species of *Hibiscus*, and after the cotton season on *Abutilon* sp., and *Hibiscus*.

Pink Bollworm (*Platyhedra gossyhpiella*).—Pink bollworm was present in large numbers in early planted cotton only. Plots planted on 23rd February were sampled for bollworms for mid-April when the pink bollworm population was 2,000 per acre. This reached a maximum of 8,000 per acre in early-May despite application of insecticide, but had fallen to a negligible level later in the month. A search was made for possible sources of infection, which were found to be principally an *Abutilon*, which carried very high populations, and to a lesser extent volunteer cotton plants in the fallows. Larvae were also recorded during September and October in the second growth of cotton plants which had been heavily attacked by American bollworm. By this time all other cotton had been picked and uprooted.

Stainers (*Dysdercus* spp.).—At no time during the season were stainers present in great numbers, and as most of the cotton was picked and uprooted by the end of August, the time at which larger populations are expected, they were of little account.

Aphids.—Aphids were troublesome all over the farm, and were responsible for a marked reduction in yield where they were not controlled. At the beginning of insecticidal treatment the level of infestation was relatively low, and declined slightly in the first three weeks of application. In the following four weeks however the intensity of attack increased rapidly so that in plots inadequately controlled all plants were affected. The treatments which were found to be most efficient in checking the build up of aphids were Endrin and the higher concentrations of BHC. Although these treatments killed the parasites and predators, as did the other treatments, they were also effective in controlling the aphids themselves.

Time-of-planting and spacing trial.—Records of bollworm were taken in the undusted plots (from the time-of-planting/spacing trial conducted by the plant breeder, Table 2) with the object of trying to find the relative attraction of cotton plants grown at different spacing and populations per acre.

The counts for bollworm population show that where plant populations are the same, the infestation is higher if the plants are more evenly spaced. This seems to indicate that the egg laying moth is attracted more to evenly spaced cotton. The environment in dense growth may also be more suitable for larval development, as there would be less variation in temperature and humidity, and may also afford more protection from parasites and predators. Yield increases from dusting were greater in evenly spaced plants so that in the absence of an insect attack more evenly distributed single plants should give a higher yield.

The seasonal larval population in February planted cotton was only slightly less than in that planted at the same spacing in March, but at the time of bollworm attack, the earlier plants held a more mature bottom crop which was not severely attacked.

These investigations are only preliminary and will be continued in more detail next year.

Dusting trial on Native-Grown Cotton.—This was a small preliminary trial to investigate the practicability and economics of dusting native cotton.

Two plots of $\frac{1}{4}$ acre each were marked out on each of six African gardens near Ilonga, and one plot on each garden was treated with 10 per cent DDT/3 per cent BHC dust at 8 lb. per acre for 8 weekly applications, using the Swaine duster.

Results from these gardens are tabulated in Table VII.

TABLE VII

SUMMARY OF YIELD FROM DUSTING TRIALS IN NATIVE-GROWN COTTON

(Yields in lb. of seed cotton per acre. Approximate value of cotton and profit in shillings per acre. Grade I 1/30 per kilo: Grade III -/32 per kilo. Cost of dusting Shs. 96/- per acre).

	Dusted		Undusted		Net Profit From Dusting
	Yield	*Value Shs.*	*Yield*	*Value Shs.*	*Shs.*
Well grown:					
(1)	1,188	659	584	291	272
(2)	865	488	570	285	106
Poorly grown:					
(3)	508	290	237	130	64
(4)	506	275	332	166	13
(5)	626	358	528	294	—32
(6)	484	267	400	209	—37
Average	690	390	441	229	64
% Grade I:	93·2		Per cent Grade I	84·5	

These measures showed that adequate control of insect pests could be achieved. However, the chief importance of these trials lay in their demonstration of the effect of the standard of agriculture and time of planting upon the possible returns from the use of insecticides. Where the cotton was well grown, the profits were considerable, and conversely, the yield increases on poorly grown cotton due to bollworm control, were not sufficient to pay for the use of insecticide.

The main conclusions from the insecticidal trials.—From a series of trials conducted by the Colonial Agricultural Insecticide Research Unit, the following information is summarised; full details of these experiments will be published later :—

A number of different insecticides were compared but only Endrin at $\frac{1}{4}$ lb. per acre proved better than DDT and BHC mixture. Endrin is cheaper and may reduce costs by a half.

Various concentrations of DDT and BHC mixture at varying frequencies of application showed that no treatment was better than the present recommendation of 1 lb. DDT and $\frac{1}{4}$ lb. BHC per acre per week for eight weeks.

Protecting the cotton for various periods through the season showed that June is the critical month for bollworm control. By dusting in July and August as well, further control was obtained. Dusting in May and not in June, and dusting in July and August only (without June), gave poor control.

A large number of dusters were compared and the Swaine dusters at Shs. 5/- each proved as good and as easy to use as rotary dusters costing £10 each. A drift duster gave poor control.

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COLONIAL AGRICULTURAL INSECTICIDE RESEARCH UNIT, ILONGA, 1954

INTRODUCTION

The most damaging pests of cotton in Eastern Province are American Bollworm, *Heliothis armigera;* Spiny Bollworm, *Earias* sp.; and Cotton Aphis, *Aphis gossypii*. In some years Cotton Stainers can be serious, but during 1954 came into the crop too late to have any effect. Pink Bollworm, *Platyhedra gossypiella*, was present in small numbers early in the season.

From previous experience it was decided that insecticide application should start when a count of flared squares (flower buds damaged by Bollworm) had reached the equivalent of 5000 per acre and continue for eight weekly applications.

The main period of Bollworm attack extended over seven weeks during June and July and the maximum egg laying was from the end of May to mid-June, representing only one generation of moths.

Experiment 1.

Results showed that a dust containing 10 per cent DDT and 3 per cent gamma BHC applied at 10 lb./acre was extremely effective for the control of local pests. Halving the strength of the dust and applying double the quantity, so as to get better cover from the same amount of active ingredient, had very little effect. However, reducing the amount of actual DDT applied per acre from one lb. to a half or quarter lb. severely reduced the degree of control obtained. Counts showed that reducing the amount of BHC applied had no effect upon bollworm control but had a very significant effect upon yield by giving a poorer control of the Aphis attack which occurred in the latter part of the season. Certain economies might be obtained by applying only DDT for the control of Bollworms and applying BHC separately only when there was sufficient Aphis attack to justify its use. However, this system would raise additional difficulties if insecticides were applied on peasant shambas where skilled supervision is not readily available.

Experiment 2a.

Several dust mixtures were compared with the standard 10 per cent DDT/ 3 % BHC to see if any would give improved control of pests. The standard dust applied so as to give 1 lb. of DDT and 0·3 lb. of BHC per acre per application was superior to either Toxaphene at 2 lb. per acre or a mixture giving 1 lb. DDT per acre and 1 lb. Toxaphene per acre, although all three dusts gave a good control. There was no indication that 1 lb. DDT and 0·3 lb. BHC per acre per treatment as a low volume spray (12 galls. per acre) was any better than the equivalent quantities of insecticide applied as a dust.

Experiment 2b.

Various new insecticides had to be compared as low volume sprays since they were not available in time as dusts.

A DDT/BHC mixture giving 1 lb. DDT and 0·3 lb. BHC per acre per application, a DDT/Toxaphene mixture at 1 lb. of each ingredient per acre, and spray giving $\frac{1}{4}$lb. of Endrin per acre, all gave very good control and were not significantly different from each other.

Toxaphene alone at 2 lb. per acre, or Isodrin at $\frac{1}{4}$ lb. per acre, both gave very poor control although bollworm damage was significantly less than on the untreated controls.

A point of particular interest is that although in Experiment (2a) 2 lb. of Toxaphene per acre as a dust gave good control of Bollworms, the same quantity applied as a spray in Experiment (2b) gave very poor control indeed. The only explanation which can be offered is that Toxaphene, owing to its sticky nature, when sprayed as an emulsion forms a deposit which is too adhesive for the insects to pick up readily a lethal dose.

Experiment 3.

This was a detailed experiment to study the effect of the time and duration of pest control upon the yield of the cotton plant and to find that period which would give the biggest return for the minimum expenditure of insecticide. Since picking will not finish on some of the treatments for some time no conclusions can be drawn at the moment except that June is locally the critical month for Bollworm control.

Experiment 4.

A comparison of DDT/BHC mixtures applied so as to give 1 lb. DDT and 0·3 lb. BHC per acre per treatment showed that a low volume spray at 12 galls. per acre gave no better control than a dust and that there was no advantage in increasing the quantity of insecticide used to give eleven applications during the two month protection period instead of the standard eight.

Experiment 5.

A Whirlwind Junior drift duster mounted on a Landrover was used to protect a four-acre bulk of cotton by applying the standard 10 per cent DDT/3 per cent BHC dust at 10 lb. per acre for eight weekly applications. Roadways at right angles to the prevailing wind were cut through the cotton at 50-yard intervals for the passage of the Landrover and dusting was always carried out during the relatively still-air conditions of the early morning.

Whilst the machine was very fast, the four acres being covered in approximately a quarter of an hour and a very satisfactory dust cloud appeared to cover the entire 50-yard swathe, it was found that adequate control of bollworms extended only twenty yards down-wind of the duster and only very poor control was obtained over the remaining thirty yards.

It is felt that if the swathe width were reduced to twenty yards the high speed of application and the small amount of labour needed might make this a possible method for treating large areas of cotton.

Experiment 6.

A number of hand dusters and a Swingfog smoke generator were compared for their efficiency in controlling Bollworms. All dusters applied 10 per cent DDT/3/BHC dust at the same rate, 10 lb. per acre, and equivalent amounts of insecticide were applied with the Swingfog.

The Swingfog gave no control of Bollworms at all, presumably because it left no residual deposit. The hand dusters all gave much the same degree of control and the results were only remarkable because a small duster designed by G. Swaine, Tanganyika Government Entomologist, and made by local tinsmiths out of tin cans and a piece of motor car inner tube, could be used to apply dust as rapidly as the much larger rotary dusters and gave as good control of bollworm. This is particularly good when one remembers that this duster, which could be made or repaired by almost any tinsmith, costs only five to seven shillings compared with the £8 - £10 for rotary dusters. The Swaine duster did not clog in wet cotton and has no parts to give mechanical trouble, both the latter faults occurred with all the rotary dusters.

Generally where insecticide applications are to be made by hand we can see no advantage in using any duster other than the cheap and simple type designed by Swaine. In fact Swaine dusters had to be used in all our experiments this year because a dozen rotary dusters costing £10 each, purchased specially for this work, gave so much trouble in the cotton field that it was impossible to use them.

Experiments 8 and 9.

These were two small unreplicated experiments to see if sugar, or a combination of sugar and a water soluble poison added to the normal DDT/BHC dust, would have any effect upon the degree of pest control obtained. As far as we could tell, any effect upon Bollworms or any other pests was entirely due to the insecticide dust and the addition of bait made no difference.

Experiment 10.

A small plot of cotton was planted early, January 31st, so that the effect of removing all flower buds for varying lengths of time could be studied. The principal aim was to see to what degree a cotton plant with a full season ahead of it could recover from damage similar to that inflicted by Bollworm, i.e. loss of young buds. Since this was a preliminary experiment and time was limited, only five plants were used for each of the treatments listed below.

A. Removal of all flower buds for the first week after the formation of the first flower bud.

B. Removal of all flower buds for the first two weeks.

C. Removal of all flower buds for the first four weeks.

D. Removal of all flower buds for the first eight weeks.

E. Removal of all flower buds for the first twelve weeks.

F. Control. No flower buds removed.

Detailed records were taken of the growth and formation of the crop, but the general trend is equally well shown by the record of weekly picking shown in Table 1.

TABLE 1

YIELD IN GRAMS IN EACH WEEKLY PICK

There were Five Plants in each Treatment

	1.6.54	7.6.54	14.6.54	21.6.54	28.6.54	5.7.54	12.7.54	19.7.54	26.7.54	3.8.54	9.8.54	16.8.54	23.8.54	30.8.54	6.9.54	13.9.54	Total
A. ...	0	10	93	123	151	176	82	53	21	4	0	0	11	0	1	0	725
B. ...	0	0	6	86	155	228	124	115	94	74	11	29	2	0	0	0	924
C. ...	0	0	0	0	0	0	289	279	214	108	79	21	3	0	0	0	993
D. ...	0	0	0	0	0	0	0	0	9	193	345	343	131	45	45	2	1,113
E. ...	0	0	0	0	0	0	0	0	0	0	0	26	98	608	317	104	1,153
F. ...	80	124	166	143	189	173	128	88	59	37	11	11	2	0	0	0	1,211

Although the total yields from the various treatments show a definite trend, this was not significant. However, it is interesting that there should be no significant difference in total yield when it is remembered that treatment E. had all flower buds removed for a total of twelve weeks, but still gave much the same total yields as the controls which had had no buds removed at all.

There were, however, very considerable differences in the time and rate at which the crop was picked on the various treatments. Naturally the removal of flower buds delayed yield and resulted in the crop being collected in a smaller number of much heavier picks. For example, the largest pick in any one week on the controls did not exceed 200 gms. and the picking extended over three months, whereas on Treatment E. there were only five weekly picks and the highest exceeded 600 gms.

The main interest of the trial lies in demonstrating that very heavy damage can be suffered by well-grown early-planted cotton without the ultimate yield being any smaller than on undamaged plants.

Experiment 11.

The standard cotton treatment at present is eight weekly applications of 10 per cent DDT/3 per cent BHC dust applied at 10 lb. per acre during June and July. Since Aphis and Cotton Stainers are apt to give trouble after the end of this period, this experiment was made to see if it might not be more profitable to apply the eight applications at fortnightly intervals. Whilst the amount of protection at any one time would be lower, a much longer period would be covered. Two additional treatments of six and four fortnightly applications were also included to see if the total amount of insecticide could be reduced.

The results showed that there was no advantage in extending the period of protection to more than two months, and the only effect of the fortnightly period was to reduce the degree of the control over the essential two months, June and July.

Yields.

The yields from these experiments were poor, generally not exceeding 400 lb. of seed cotton per acre, and falling in one case to 169 lb. of seed cotton per acre. These yields were from treatments where Bollworm control has been good, the untreated controls yielded almost nothing. It is believed that these low yields on areas where Bollworms had been controlled were largely due to late planting, made worse by poor seed which made considerable replanting necessary, and weed growth which was difficult to keep in check. Planting on these experiments was during the last week in March and the first week in April. Reference to the yield figures below from a planting date trial carried out by the E.C.G.C. plant breeder, Mr. Smith, make it almost certain that the principal reason for low yields on these experiments was late planting.

TABLE 2

PLANTING DATE TRIAL

(Cotton dusted for protection against bollworms,)

	Yield of seed cotton
Cotton planted 23rd February	1,300 lb./acre
Cotton planted 18th March	784 lb./acre
Cotton planted 13th April	28 lb./acre

Summary and Discussion.

None of the insecticide treatments tried this year were any improvement upon the standard eight weekly applications of 10 per cent DDT/3 per cent BHC dust at 10 lb. per acre during June and July.

Where treatment is to be done by hand, the simple Swaine Duster is to be preferred on grounds of simplicity and economy.

Experiments carried out by Valentine on peasant fields showed that these measures would give adequate pest control on native grown cotton. However, the chief importance of these trials lay in their demonstration of the effect of the standard of agriculture upon the possible returns from the use of insecticides. Where the cotton was well grown, the profits from the use of insecticides were considerable, and conversely, yield increases on poorly grown cotton due to bollworm control were not sufficient to pay for the cost of insecticides. The conclusion seems unavoidable that if insecticides are to be used on cotton in Eastern Province, simultaneous steps must be taken to ensure that it is well grown. Insecticides are not a substitute for good agriculture, but an addition.

It was thought originally that the only hope for increased cotton production in Eastern Province was the use of insecticides, but judging from this year's work there may be alternatives to this. If insecticides are to be used at all, cultural methods must be improved to make them profitable. But our general impression is that once the cotton is early planted and well grown considerable yield increases will be obtained due to this alone. The untreated control on the best grown African fields yielded more cotton than some of the treated areas on badly grown fields. In addition, early planted cotton may form a considerable part of its crop before the bollworm attack develops, and in any case, as shown by Experiment 10, can stand very heavy loss of fruiting points without showing any decrease in yield.

It is much too early to say that use of insecticides can be avoided, but it is fairly certain that improved cultivation, which is vital if insecticides are to be used, will give increased yields and in itself may very much reduce the importance of insecticides. Time of planting, standards of cultivation, the method of crop formation by the cotton plant and its reaction to damage together with the importance of maize as a source of bollworms are so inter-related that it is difficut to forecast the effect of changing one of these upon any of the others.

K. S. McKinlay
Entomologist

East African Agricultural and Forestry Reserach Organization

COFFEE RESEARCH STATION, LYAMUNGU

SUMMARY OF THE WORK CONDUCTED DURING 1954

I.—Weather

During the first quarter of the year, precipitation was light amounting to 4·68 inches. Two inches of this fell towards the end of February, and brought out a good but belated flowering of the coffee. March was exceptionally dry. The long rains commenced at the beginning of April and tailed off at the end of May after producing 39·09 inches. A further 1·35 inches, spread over twelve days, fell in June, giving a total for the second quarter of 40·44 inches. This compares with an average of 43·28 inches for this quarter over a period of 21 years, the extremes being 76·31 inches in 1937, and 20·90 inches in 1949. The second half of the year was extremely dry and only 4·51 inches were recorded. From the end of June there were only four effective showers yielding more than one quarter of an inch and these fell approximately at monthly intervals. The short rains virtually failed in this area.

II.—Crop

Once again the crop season was greatly extended, with the main crop being harvested towards the end of November as a result of the good flowering in early March. An early flowering occurred in October 1953 on those trees not bearing a heavy crop at that time, and this flowering necessitated "fly" picking commencing in May. Cherry equivalent to an approximate total of 48 tons of parchment coffee from a total cropping area of 126·75 acres was harvested.

III.—Station Experiments—Coffee

A.—Improvement of Planting Material

At the end of last year, very heavy leaf-fall occurred, consequent upon a severe attack of *Hemileia*, in the clonal selection trials (Experiment XVIII). This experiment was irrigated in February and new leaf was brought out immediately as a result. As was to be expected after the very heavy crop last season, there was only a light crop on most of the trees in this experiment this year. The highest yielding clones, however, maintained their marked superiority; KP423, KP162, KP532, H66, KP154, and X321 (all selections within the Kents variety) were outstanding in this respect, yielding from 2½ to 6 times as much as the other selections in their respective squares in this year of low yields.

Individual tree recording was commenced on two Latin Squares, one on the single stem and one on the multiple stem system.

All trees have made very good vegetative growth throughout the year, helped on by two further irrigations since July. It is noteworty that in the absence of any appreciable crop, the incidence of *Hemileia* has been virtually non-existent this year. In other areas on the Station where cropping has been at a high level, *Hemileia* was severe.

In Experiment IIIB, where clones are being compared with first and second generation seedlings and seedlings of the clone, high yields, estimated as an ultimate overall mean of over 18 cwt. of clean coffee per acre, were obtained in

this, its third year in the field, following an overall mean of 8·26 cwt. per acre last year. The clone has not maintained its marked superiority, and this year the second generation seedlings have shown enhanced yields.

The recording of individual trees in Experiment II (seedling selection trials) was continued.

One new seedling selection trial, containing 28 seedling progeny and two key clones, was planted in a lay-out of single tree plots in 32 randomized blocks. The material was mostly derived from the highest yielding selections in the clonal selection trials with the addition of four new untried ones.

Seedlings of 27 new introductions were planted out in plots of 16 trees in the Variety Collection Extension.

B.—Improvement of Growing Conditions

(1) *Cultural Experiments.*—By the end of the 1953/54 season, Experiment V (mulch, compost and Sulphate of Ammonia) had been recorded for 12 years. As no further information of value was likely to accrue the treatments were not applied in 1954, but the plot yields were recorded in order to assess the residual effect of the treatments. In addition, the recording by individual trees of the most vigorous clones was commenced.

A heavy crop was set in Experiment XV (irrigation and mulch) but severe leaf-fall occurred towards the end of the year, due to "yellowing", *Hemileia*, Scaly-bark and leaf-miner.

The results from Experiment XIX, where two densities of interplanted bananas and two rates of application of manure are being compared, confirm that interplanted bananas have a depressing effect on the yield of coffee. The differences due to manuring, however, are not so marked this year, though the same tendency, namely an increase at the lower level but not at the higher, is maintained.

A spacing experiment was planted with trees at 540, 960, 1,500, 2,160 (square), 2,160 (in double rows), and 2,940 to the acre. The experiment is so designed that the effect of interplanted bananas on both single and multiple stem coffee can be determined. In addition, provision has been made for the determination of the respective yields of coffee and bananas when grown separately.

An investigation into the effect of banana and elephant grass mulches, applied both before and after the rains, on the level of soil nitrate was started in March and will be continued for one year. The results so far available indicate that, as is to be expected, nitrate level is inversely proportional to the soil moisture level when this is high (i.e. 50 per cent on the ovendry basis, during the rains) and approximately proportional when soil moisture is lower than this. On the whole, banana trash applied after the rains has given the highest nitrate values.

Much attention is now being paid to leaf analysis in the study of the nutritional status of coffee and regular monthly sampling and analysis of leaves is being carried out on several experiments. Experiment XV, in which banana mulch has been shown to give considerable increases in soil nutrient levels, is being investigated to see if this is reflected in greater percentage composition of the nutrients in leaf tissue. Monthly leaf tissue analysis of high-yielding selections in the Kents Plot and of two selections in Experiment XVIII is being carried out to compare nutritional status of the trees during "ON"—and "OFF"—yielding years. Insufficient results are at present available to draw any conclusions.

Monthly leaf analysis is also being done on coffee leaves sampled on an Estate in the Usambaras in the hope that comparisons with healthy coffee from the Coffee Research Station, would indicate deficiencies and assist in the design of a suitable fertilizer experiment.

Experiments on the use of chemicals in removing mucilage from pulped coffee have been continued. One per cent caustic soda, or a mixture of lime and Magadi household soda (or Magadi soda ash) equivalent to this, will clean the coffee in approximately 10 minutes. The liquoring reports on the samples so treated warrant undertaking large scale experiments. These will be commenced next season. The use of small quantities of enzymes will clean the coffee completely overnight and higher enzyme concentrations or lower caustic soda strength, may be used in order to clean the coffee in two to six hours. It is hoped from weighings of coffee treated with these various chemicals, to comment on the claim that there is less loss in weight during accelerated fermentation than with normal fermentation.

In collaboration with the National Institute of Agricultural Engineering in England (Grain-drying section), a laboratory-type hot-air drier has been constructed and experiments on the drying of coffee have commenced. It is hoped to obtain from these experiments basic information for coffee-drying.

(2) *Pruning Experiments.*—Once again the highest yield has been given by those plots which were pruned during the month in which harvesting of the previous crop was completed (Experiment XX). Yields were low throughout, and those from the remaining plots tended to be somewhat erratic. This experiment has now been carried on for six consecutive years, and it is considered that the advantage of early pruning has now been proved; it will therefore be discontinued at the end of the 1954/55 crop season.

Good yields were obtained from Experiment XXI, designed to compare two methods of establishing the single stem pruning system and three methods of establishing multiple stem. The old system of bringing up three suckers from below 10 inches on the main stem was again outyielded by both the single uncapped stem and the two stems-cum-skirt. The single stem capped at 36 inches (two cappings) heavily outyielded the trees capped at 21 inches (three cappings) as was to be expected since the second storey in the latter was kept down until March.

IV.—Nurseries

(a) *Cuttings.*—The monthly planting experiment was continued in the old rooting media; no other experiments were undertaken.

Material was taken for the planting of a selection trial for the Moshi Native Coffee Board in 1955, and as keys for further seedling selection trials.

(b) *Seedlings.*—Another new nursery was prepared and last year's beds were again utilised for further sowings for a new pruning and spacing experiment, for the planting up of progeny of the selections as part of the programme for the further improvement of planting material and for another selection trial. Germination of seed for the latter was poor. Seed of eighteen new introductions from Central and South America was sown.

V.—Breeding

Seed resulting from the crosses and selfings made in the 1952/53 season was sown in the nursery, and good germination resulted. Considerable variation in vigour is apparent, even at this stage.

VI.—Seed

The heavy demand for seed continues. Orders from the 1954/55 crop up to the end of December amounted to over 4,600 lbs., and still more orders are expected.

VII.—Pests and Diseases

White Stem Borer—(*Anthores leuconotus*).—Very few young borers were extracted, and the old ones were probably hatched from eggs laid in 1953 before the Dieldrin treatment was applied. It would therefore appear that the Dieldrin treatment was effective. It is being repeated again this year on all the coffee at the lower end of the Station.

Antestia—(*Antestia lineaticollis*).—Some Antestia were present early in the year but were controlled by incorporating DDT in the pre-rains copper spray. Incidence during the remainder of the year was light.

Thrips—(*Diarthrothrips coffeae*).—Thrips appeared during the hot weather prevailing at the end of November and experiments infested were sprayed with DDT.

Leaf-miner—(*Leucoptera* spp.).—A very severe attack, resulting in severe defoliation, occurred towards the end of the year on unshaded coffee which was bearing a heavy crop and was in a somewhat debilitated condition. It was also severe on the newly planted coffee, but no defoliation occurred here, and irrigation brought out a succession of new leaf.

Mites—(*Hemitarsonemus latus*).—The incidence of this pest was less this year.

Mealy bug—(*Pseudococcus filamentosus*).—Only very light and occasional outbreaks occurred.

Green Scale—(*Coccus africanus* and *Coccus viridis*).—This was severe in parts of Experiment XVIIIA. Infested trees were sprayed with Triona after treating the stems with Dieldrin.

Leaf Rust—(*Hemileia vastatrix*).—This disease was again fairly widespread on those trees bearing a heavy crop, and some severe defoliation occurred. It appeared this year after the long rains, somewhat earlier than usual. Dr. Branquinho d'Oliveria of Sacavem, Portugal, has isolated a number of strains of *Hemileia vastatrix* from material originating from the coffee areas of the Eastern Hemisphere. Eight strains have been isolated from material provided by this Station and one of these has proved to be the most virulent so far discovered. It is worth noting that the selections H66, KP423 and KP532 are immune to all strains so far tested except this one.

Scaly bark—(with which *Fusarium stilboides* is associated).—This has proved to be fairly widespread on the older coffee on the Station which has been grown on the single stem system. It is also present in the mother stems of the older multiple stem coffee. The three younger stems, however, do not appear to be affected.

H.61—die-back.—This die-back on some trees of the clone H.61 in Experiment XVIIIA again made its appearance.

Vermin.—Moles again proved troublesome and large numbers were trapped.

VIII.—Off-Station Experiments

A rejuvenation experiment was started on an estate in the Kibosho area. Treatment consisted of stumping with the object of bringing up new suckers to be trained on both multiple and single stem and uprooting and replanting. Some plots were left as controls to be continued as normal estate practice.

Seed was supplied to the Moshi Native Coffee Board for further selection trials.

Seedlings were supplied for the planting of two fertilizer trials in the Usambara and Pare mountains respectively.

The first crop was recorded from the single tree plots of the selection trial at Mbosho which was planted in April, 1952, one single tree yielding at the rate of 27 cwt. of clean coffee per acre after only two years in the field. Two clones yielded over 12 cwt. per acre. These results must be attributed to rapid growth induced by irrigation in a warm climate and the use of genetically good trees, which had good root systems and were well-planted.

IX.—Miscellaneous Experiments

(1) *Weedicide Observation Trials.*—Trials for the eradication of couch grass (*Digitaria scalarum*) in coffee using TCA (Trichloroacetic Acid) were continued. Further trials with CMU (3 (p-chlorophenyl) 1, 1-dimethylurea) and Chloro. IPC (isopropyl N-(3-chlorophenyl) carbamate) at varying rates were also laid down.

Chloro. IPC., CMU and TCA at different concentrations were also applied to plots containing *Cyperus* sp.

PCP. (penta-chlorophenol), TCA, and 2, 4-D were applied alone and in combination for the purpose of eradicating *Panicum trichocladum* growing in bananas.

(2) *Wound Dressing Trials.*—Fourteen different fungicidal dressings and paints were applied to the cut surfaces of the main stems and primary branches of coffee trees. Hormone substances were incorporated in some of the dressings in an attempt to assist callusing.

No results are available to date.

X.—Animal Husbandry

At the beginning of December the Zebu herd consisted of 104 cows, heifers, and heifer calves, 59 bullocks and bull calves, and 2 bulls.

Twenty-three bull calves and 20 heifers were born during the year, and there were 5 deaths, 1 from" bloat", 3 from foot and mouth disease, and 1 from pneumonia. Five steers were slaughtered for meat, and 2 cows and 5 calves were sold.

Foot and mouth disease broke out in the head of dry cows, heifers, and bullocks early in September. The disease was first apparent on about a dozen animals but by the third week all in this herd appeared to be infected. There were three deaths. Except for one calf, there has as yet been no outbreak of the disease in the milking herd.

All the cattle received protection from rinderpest in August, using Lapinised Vaccine.

There were no cases of "fly".

The highest lactation yield during the year was 377·8 gallons in 313 days given by Kamba I in her first lactation.

XI.—Visitors

Overseas visitors to the Station included Dr. H. G. H. Kearns of Long Ashton Research Station, Bristol; M. Alewijm, Agricultural Adviser to the Netherlands Exploration Syndicate; M. D'Houre of the Inter-African Pedological Service, Yangambi; members of the Commonwealth Parliamentary Association; Mr. D. Rhind, Secretary for Colonial Agricultural Research at the Colonial Office; Mr. G. A. Stewart of the C.S.I.R.O., Australia; Mr. G. V. Jacks, Director of the Commonwealth Bureau of Soil Science; Sir Geoffrey Clay, Agricultural Adviser to the Secretary of State for the Colonies; and Dr. A. van der Meulen of the Citrus Research Station, Nelspruit, South Africa.

F. R. Sanders,

Senior Research Officer

SUMMARY OF THE WORK CARRIED OUT AT MARUKU COFFEE STATION, BUKOBA, 1954

The functions of this Station are to investigate means of extending the cultivation of robusta coffee and bananas into those parts of the Lake Littoral area of Bukoba District where there is at present only grassland on an extremely impoverished soil. Virtually all the better land has now been planted and expansion can only take place on these poorer soils.

During 1954 investigational work was continued into the questions of the low fertility status of the local soils and its effect on the establishment of bananas and coffee; methods of improving fertility by manuring, and the integration of stock husbandry with local crop practice. Summaries of the more important experimentation carried out during 1954 are given below:

Soil Fertility Trials

Four further trials were completed with the object of elucidating the very poor fertility status of the station; the indicator crops were eleusine and bulrush millet. As in past years the extraordinary patchiness of the soil, not reflected in chemical analysis, again made experimentation difficult. Treatments rang the changes on the three major elements, calcium and dung, and the results indicated that a solution to the problem will not be found on these lines.

Banana Establishment Trial

This is a 6×6 Latin square experiment with the aim of finding a manurial treatment which will give satisfactory establishment and subsequent growth of bananas.

None of the treatments has given satisfactory results. Yields are so poor that they are inadequate as a measure of the suitability of the manurial dressings.

Banana Plantation

The first part of this was planted in 1949, since then the plantation has been extended as opportunity occurred, an additional $1\frac{1}{2}$ acres having been planted in the period under review.

Heavy dressings of farmyard manure have been applied each year but these have not been sufficient to produce good growth.

Kudzu vine was inter-planted in 1950 to give soil cover and generally to improve soil conditions. This crop took some eighteen months to become properly established and then gave a very good cover. It was cut back periodically and fed to stock but by the beginning of this year it seemed to be competing so strongly with the bananas, having by this time built up a very considerable root system, that it was decided to dig it all out except for a small patch.

Coffee seedlings were inter-planted in the older part of the plantation in October, 1953. The holes were dug out and refilled with compost and top soil. Most of the seedlings having become established but growth is very variable.

Coffee Progeny Trial

Growth of the coffee trees is fairly satisfactory, although there appear to be nutrition deficiency symptoms on some trees.

The area has been kept well mulched. It has not yet been possible to plant shade trees. A "hedge" of elephant grass has been established round the area in order to simulate the hedges surrounding the coffee and banana plots in the district. Two rows of the grass are slashed periodically in rotation so that there is always tall grass surrounding the area, with more coming on to take its place.

Pasture Observation Trial (Pasture Trial II)

This was laid down in January, 1953, to study the effect of fertiliser, manure and lime on the natural grassland. Each paddock is $\frac{1}{4}$ acre and there are no replications.

Yield has been measured in terms of the weight of grass cut annually. Cutting this year was early in July. The grass is weighed green and then again until further loss of weight is negligible.

Final weights were as follows :—

Ca	...	...	...	6,776 lb.	per acre
NPK	...	...	...	6,504 lb.	„ „
D	...	...	...	5,736 lb.	„ „
Control	...	...	...	3,844 lb.	„ „
Primeval	...	...	...	2,748 lb.	„ „

The treatment "primeval" is intended to simulate the conditions of the open grasslands. The plot is burnt annually, after the grass has been cut and weighed.

Cattle

There were 37 cows in milk during the year, yielding an average of 78 gallons per cow in excess of that taken by calves which are generally suckled throughout the lactation. The average yield for the Ankole herd was 74 gallons and that for the Zebu herd was 80½ gallons. The highest yielder in each herd gave 153 gallons (Ankole) and 161 gallons (Zebu). Thirty-one calves, of which 19 were heifers, were born during the period under review.

The average calving interval is 399 days.

Feeding has continued on the same lines as in previous years. Cows in calf receive concentrates for the last 6-8 weeks before calving, and for production thereafter. It is not considered that the pastures provide for more than maintenance.

Summary of Investigational Work

It has been shown that with proper management cattle can be maintained satisfactorily, producing a calf per year, depending largely on the "natural" grasslands for their food, but supplemented with concentrates and minerals to a small extent. The calf mortality rate, which is so high amongst African owned herds, can be reduced to negligible proportion if the calves are adequately fed.

On the Crop Husbandry side less progress has been made. There are still growth limiting factors which remain unidentified. From the results of experiments and a large number of soil analyses it seems fairly certain that these factors are not limited to the major nutrients although there may be problems of non-availability of nitrogen and possibly phosphorus at certain times or under certain conditions.

AN ACCOUNT OF THE WORK AT MBOSI COFFEE SUB-STATION, SOUTHERN HIGHLANDS PROVINCE, FOR THE YEAR 1954

For the third consecutive year climatic conditions were not favourable. Rainfall was very low in April (only 1 inch) and during the next six months only 0·78 inches of rain fell. This seven-month dry season had a serious effect on plant growth.

Establishment of plants in the mulching experiment laid down in January has proved somewhat difficult, there being 8 per cent deaths plus 15 per cent insect damaged and weak plants which required replacement. Of the deaths, the greatest number occurred where *Hyparrhenia* sp. was used as a mulch. Insect damage was mainly due to cut worm and stem borer but all the trees have now been treated with Dieldrin.

The pruning trial also planted in January made satisfactory growth considering the adverse weather conditions but again 8 per cent replacement due to deaths and 17 per cent replacement due to unthrifty plants was necessary.

Coffee seed from 40 selections was planted in the nursery, the germination being better than that of last year. It is intended to use this nursery for some time and a system of fallowing will be applied to the beds. Seedlings of Cypress, Croton and Eucalyptus were also produced.

Work continued on "die-back" and "black tip" of coffee. The former was much in evidence during August and September and "black tip" appeared with the onset of the rains in November although some damage was evident in September. Spraying trials using trace elements are being conducted under the auspices of the Government Chemist to try and find a solution to this problem.

In addition to work on coffee, variety and fertiliser trials for both wheat and maize were carried out, the results of which have been included in the report of the Agricultural Officer (Experiments) Iringa (see page).

Niger seed, linseed, oats, sunnhemp, and several strains of lupin and soya beans were also sown whilst the orchard crops, Queensland nut, Pecan nut, peach, apple and citrus continued to make satisfactory growth. The coffee factory is nearing completion and should be ready for the next season.

SISAL RESEARCH STATION, MLINGANO, NGOMENI

ANNUAL REPORT FOR THE YEAR 1954

PART I

I.—Staff

Officer in Charge	G. W. Lock, O.B.E., N.D.A., N.D.D., C.D.A., A.I.C.T.A., Senior Research Officer.
Plant Physiologist	E. C. Diekmahns, B.Sc. (Hons.), Dip.Agric. Sc.(Cantab.).
Soil Chemist	F. Leutenegger, Dr.sc.tc., Diping. Agr. E.T.H.
Scientific Assistant	J. F. Osborne, B.Sc.
Field Officers (Agriculture) ...	R. Simpson. D. M. Mowat.
Librarian and Secretary ...	Mrs. G. W. Lock, (part-time and temporarily up to 31st March 1954).

Owing to sudden illness the Senior Research Officer was sent to the United Kingdom for medical treatment and vacation leave on 26th April and he was away until 2nd December. The Plant Physiologist was also absent on vacation leave from 9th March until 22nd September when he assumed charge of the Station pending the return of the Senior Research Officer. Up to this date the routine work was carried on very ably by Mr. R. Simpson, Field Officer (Agriculture) with a depleted staff. The Director of Agriculture arranged for the Station to come under periodical supervision by Mr. C. J. McGregor, Regional Assistant Director of Agriculture, Northern and Tanga Provinces. The Soil Chemist went on vacation leave on 18th September and is not due back until 1955. The Scientific Assistant looked after the laboratories during the absence of the scientific officers concerned besides maintaining the library register.

The Senior Research Officer was unable to make many calls upon research workers and others in the United Kingdom during his leave but the Plant Physiologist visited several agricultural research stations. He also met the Senior Research Officer in London on two occasions for discussions on the progress of work at Mlingano. The Soil Chemist attended the Fifth International Congress of Soil Science which was held in the Belgian Congo from 15th August to 3rd September and later in the year he visited the Rothamsted Experimental Station and the Department of Agriculture, Oxford University.

The Station employs about fifty Africans as clerks, recorders, laboratory assistants, drivers and artisans and approximately another hundred as field workers. Apart from the resignation of one senior recorder, there were few changes in the African staff during the year.

Touring

The Senior Research Officer visited estates and external trials situated in the Tanga, Korogwe and Pare Districts during the first quarter of the year and further visits were made in December. The Soil Chemist toured the Central Line and

Northern Province during June and July making advisory visits to estates while the Plant Physiologist called on estates in the Korogwe area during October and November. Both Field Officers travelled extensively mainly in connection with routine duties on external trials.

Buildings and Equipment

Building work was confined to the upkeep of existing premises. Three houses were let to tenants during the second half of the year. New equipment purchased included an air-conditioning plant for the spectrographic laboratory, a fume-cupboard extraction system, and a projection attachment for a micro-photometer. The large spectrograph was installed ready for use.

Electricity, Gas and Water Supplies

Electricity and gas supplies were satisfactory throughout the year. The large water storage tank for the laboratories ran dry on 8th March and analytical work was held up until 22nd March when rain replenished the supply. It transpired that this temporary shortage was attributable to an underground pipe leading to the tank becoming defective thereby causing loss of catchment water. The dam filled to only twelve feet in May but despite poor rains the present supply is expected to last until the long rains next year.

Clearing and Planting Work

Half a hectare of bulbil nursery was planted in April as usual. Five hectares of land were stumped, ploughed and planted with maize during the main rains. Yields were unsatisfactory owing to lack of rain and a severe attack of rust (*Puccinia polysora*). A second sowing in September has made better growth but it needs rain to reach maturity. Seven hectares of derelict ceara rubber and bush were rough-felled. Bush growth was kept down in all the developed parts of the Station.

Citrus

Over 1,277 budded citrus trees were sold to estates and other purchasers. A considerable quantity of fruit was sold for juice extraction and canning. The establishment of nurseries on new land near the dam has been difficult owing to dry weather but thousands of rough lemon stocks are growing well in seed-beds. One overseer and three assistants are posted to Mlingano by the Department of Agriculture for citrus propagation work.

Other Crops

Plots of ramie (*Boehmeria nivea* and *B. utilissima*) have made very poor growth this year. The Station maintains a large area of elephant grass and a part of this provides fodder for the cattle.

Cattle

There are 38 head of cattle kept in fly-proofed byres comprising 1 bull, 16 milking cows, 7 yearling heifers and 14 calves. Of the young stock, 20 heifers are grade Ayshire and Zebu crosses and these will form the foundation of the milking herd in future. Eight beasts were slaughtered for meat and there were 5 casualties among the calves.

Weather

This year ranks as a dry year. The total rainfall amounted to 36·84 inches which is nearly 10 inches less than the average for the past 19 years. The first three months were hot and dry. Light showers fell more or less continuously throughout April and May but June was unusually dry. September was another dry month while the small rains in October and November were short of expectations. Hot drying winds prevailed in December. Rain fell on 121 days compared with the average of 141 days and this distribution, although more erratic than usual has helped to keep the sisal growing besides preventing the Station from acquiring a dry and parched appearance.

RAINFALL RECORDS

	1954		Average for 19 years	
	Inches	*No. of days*	*Inches*	*No. of days*
January	0·30	3	1·12	5
February	1·69	6	1·41	5
March	4·04	7	4·25	10
April	6·91	20	7·26	17
May	7·73	17	9·80	20
June	0·78	7	2·10	11
July	1·13	9	1·76	12
August	2·57	13	2·33	13
September	1·14	11	3·43	13
October	4·42	15	5·49	12
November	2·89	10	4·69	12
December	3·24	3	3·09	11
Total	36·84	121	46·73	141

The number of hours of sunshine recorded was nearly as high as that for last year. Maximum temperatures ranged from 81-96° F and minimum temperatures from 66-73° F depending upon the time of year.

Programme of Experimental Work

Fortunately the new experiments planned for 1954 were well in hand when the Senior Research Officer was taken ill and consequently there was no hiatus in the programme of field investigations. Three new trials were started at Mlingano and two on outside estates in addition to three nursery experiments.

During the year the Station was responsible for carrying out 41 trials, including 14 external experiments, comprising 2,213 plots. Two external trials which finished during the year have not yet been replanted; a third trial at Mlingano also ended. One external trial has been damaged so severely by baboons that it can no longer provide any reliable yield data although the responses to the manures are obviously very great. It is intended to maintain this trial for observational purposes only.

Four of the external exploratory manurial trials were cut for the first time. As these experiments are sited on sisal-worn land, fibre yields were not very high and the results are rather variable.

Annual reports on experiments dealing with a long-term crop such as sisal inevitably bear a stamp of sameness and tend to be repetitive. Yet although the theme of the research undertaken may not change much, the knowledge

which is being accumulated becomes wider every year. At Mlingano the main emphasis of the investigations now in progress is on the maintenance of soil fertility, manuring and the nutrition of sisal. Three quarters of the trials are concerned with these matters while one quarter covers plant management and cognate subjects such as spacing, cutting, the use of insecticides and the breeding and testing of agave hybrids.

The factorial manurial trial has been carried a stage further towards finality. Many of the best plots have poled out and the total yield of fibre obtained during the life-cycle of this sisal compares favourably with the yield from the same land when it was virgin. This shows that sisal yields can be maintained with the aid of fertilisers, if need be, although the quantities used were (as it has been shown since the trial was started) unnecessarily high in certain respects. The best response has been to calcium in the presence of nitrogen, particularly from the angle of rate of turnover. Sisal in the nitrogen fertilised plots has grown fastest and given the quickest returns. The response to phosphate has been about half that attributable to calcium while potash has not affected yields at all. Young sisal in two fertiliser trials planted twenty months ago on old land is now showing better growth mainly as a result of applying nitrogenous fertilisers. The cutting of external exploratory manurial trials has begun and the early figures are rather disappointing but the final results of the banding disease trial are excellent.

The Cultivation trial, which is now nearly twenty years old, besides showing the importance of weed competition to young sisal, indicates that yields cannot always be maintained on acid soils solely through the use of a vegetal cover on the soil. Likewise a grass ley of two years duration between cycles of sisal has not sufficed by itself to improve the growth of sisal which is still young; better results are being obtained on the grass ley plots which were treated with fertilisers although here again it would appear to be best to apply nitrogen directly to young sisal rather than indirectly through the grass ley.

Bulbil nursery manurial trials continue to show the great value of sisal waste both as a manure and a mulch.

In one cutting trial the effect of heavy cutting from a normally timed first cut onwards has reduced fibre yields by over 3 tons per hectare, or 16·5 per cent, compared with light or reasonable cutting. In another trial now $3\frac{1}{2}$ years old, the plants have been severely stunted through heavy cutting which was started prematurely early and it is expected that yields will ultimately be depressed to an even greater extent.

Spraying trials begun in 1953 still show the value of Dieldrin for reducing losses of transplants through weevil damage. This was a wet year and the results obtained during 1954 are not so impressive largely owing to dry weather restricting weevil breeding.

Field Trials on the Station

The following review touches upon the salient features of the results obtained to date.

Cultivation Trial.—As mentioned earlier this experiment is now nineteen years old. It will be recalled that there are six treatments which vary from clean weeding to no weeding at all. Clean weeding has accelerated soil impoverishment and the fibre yields of the third cycle sisal under this treatment will be about half of

those obtained during the first cycle on virgin land. The fibre is also of poorer quality. Two of the intermediate treatments, namely periodical weeding and a cover crop, yielded less during their cycle and in one case the third cycle sisal has severe banding disease. Second cycle sisal growing in competition with bush is healthy but has given light yields.

Soil samples were taken from each plot recently and pH determinations show that the acidity of the soil has been increased from pH 5·80 for the plots which have always been under sisal and bush to pH 5·00 for those carrying sisal which has been clean weeded and cultivated deeply. Least change has occurred in the plots where cultivation has simply comprised cutlassing of the weeds.

Spacing Trial.—The spacing trial has also been in progress since 1936 and soil deterioration has begun to affect the growth of the sisal especially in the high density (6,000 or 10,000 plants per hectare) plots. Third cycle yields of the lowest density plots (1,666 or 2,500 plants per hectare) are less than those for the second cycle while the aggregate yields for three cycles are much lower than those for densities of 4,000 plants per hectare upwards.

Spacing × Cutting Trials.—In these experiments various spacing and cutting systems are tested in combination within the scope of a single trial. The first of these trials was replanted for a second time in 1949 and it is now 5½ years old. Growth has been much slower compared with the first cycle, the sisal being paler and less robust. Both bole rot and purple leaf tip roll and withering have been prevalent. Fibre yields obtained so far tend to confirm the results of the first cycle although they are at a lower level. These were that plant population and commencement of cutting were more important factors than spacing or cutting cycles. Laboratory tests show that the soil has become more acid particularly in those plots which have carried a plant density of 6,000 per ha. for the past twelve years. This trial is scheduled for cutting out to make way for a new manurial experiment.

Heavy poling has occurred in all the 4,000/ha. and 5,000/ha. plots in the Severity of Cutting Trial which is now 7 years old. This experiment is on virgin land and current fibre yields have been good rising up to 20 tons per ha. for the high density treatments. Commencing to cut at 1½ years and later has had very little effect so far and likewise with the various cutting cycles of 6, 9 and 12 months. Severity of cutting, however, has had a big effect both on yields and poling. Sisal cut heavily, leaving only 8 leaves per plant each time, has yielded over 3 tons less than that cut more reasonably. Heavy cutting has also deferred poling. The full effect of the treatments cannot be seen yet as the trial is not over.

The Early Cutting Experiment is in an interim stage, being 4½ years old. It is sited on new land. Fibre yields to date vary between 4·5 to 5·0 tons per ha. Repeated hard cutting from an early stage onwards is resulting in dwarfed plants which are yielding much shorter and lighter leaf.

Fertility Trial.—The purpose of this long-term experiment is to ascertain the value of certain resting crops and systems of rotating cycles of sisal with fallow periods for maintaining soil fertility. Three of the twelve treatments comprise sisal planted immediately after sisal; this crop is nearly five years old and it has been cut three times. Fibre yields have been quite good especially on plots kept free of weeds by disc harrowing. The soil, however, is losing its structure and this method of cultivation cannot be recommended.

Young sisal planted over two years ago after a resting period of two years has grown quite well but its rate of growth is slower compared with the first cycle because it is not yet ready for a first cutting. Possibly a lower nitrogen status of the soil may be responsible for this difference. Sisal after *Tephrosia candida* or elephant grass treated with nitrogenous and phosphatic fertilisers still looks well and should come into bearing shortly.

Grass Rotational × Manurial Trial.—This trial is sited on land which has been under sisal continuously for 15 years. Plots were rested for two years under grasses which were treated with lime, nitrogen, phosphate and potash manures and then replanted with sisal. The sisal is now 20 months old but it will not be ready for cutting at two years from planting such as is customary with sisal on new land or that given plenty of nitrogenous fertiliser. The most promising plots are those having residues of lime or phosphate. The nitrogen applied to the grass appears to have been lost to a large extent because some of the sisal is pale green and is growing slowly.

Factorial Manurial Trial.—The current results of this important trial have been commented upon already. The combined yields of the first to third cuttings (ignoring the time factor) show significant responses to lime and phosphate only, that for nitrogen barely reaching significance. When, however, the yields obtained during the 5½ years duration of the experiment are compared there is a large response to nitrogen because these plots have grown faster and consequently have been cut more often. Lime, and phosphate to a lesser extent, have also lead to increased yields but potash has had no effect. The backward plots have only been cut three times so far yielding about 3·74 tons per ha. while the rapid growing sisal has poled out after yielding about 15·5 tons per ha.

Fertilizer Placement Trial.—Only nitrogenous and phosphatic fertilizers have been used in this trial each of which have beeen applied in different ways such as (i) on the rows of sisal; (ii) on the grass cover strips between the rows of sisal, and (iii) broadcast. There has been a marked response to nitrogen while that for phosphate is much smaller. As regards placement the differences are not very great but it seems to be best to put the fertilizers on the rows of sisal.

Mulching Trial.—The sisal in this trial is 5½ years old and much poling has taken place. Best results have been obtained from a mulch of 50 tons of sisal waste per ha., applied during the first two years of the sisal; and this treatment is followed closely by inorganic fertilizers. Elephant grass, coconut cake (and cotton seed to a lesser extent) have each improved yields compared with the control but the differences are not large enough to be significant.

Ridging Trial.—This experiment has been in progress for nearly seven years and most of the sisal has now poled out. A high plant population (6000/ha.) on good land has been conducive to heavy yields. Up to the present ridged sisal has yielded 19.1 tons per ha. comared with 17.6 tons for that planted on the flat but the difference between the two has narrowed now that poling has begun. This difference may be reduced still further because poling has been heaviest in the ridged plots. The advantage of ridging the soils at Mlingano appear to be limited to the stimulus the double depth of top-soil gives to the growth of the sisal during the first two years when it is young. It seems unlikely that ridging would be economic in practice on these soils.

Interplanting Trial.—Maize, sorghum and beans were planted between single and double rows of sisal in this experiment for the first two years. The sisal is 5½ years old, has been cut four times and it is now poling fairly heavily. Current

yields are about 12 tons per ha. and the only difference of any significance is the depressing effect due to sorghum. This intercrop brought about wilting of the sisal when it was young thus retarding its growth and the rate of yield. Half of the interplanted plots were treated with artificial fertilizers without affecting the sisal. Likewise there is no difference between single and double row planting (5,000 plants per ha.)

Sisal Waste Manurial Trial.—The treatments in this trial comprise (i) control, no waste applied; (ii) Total waste effluent as obtained from a decorticator; (iii) Solid waste only; (iv) Liquid waste only; and (v) 50 tons per ha. solid waste mulch plus dressings of nitrogenous and phosphatic fertilizers. With the exception of the last treatment, the quantity applied per hectare was equivalent to that amount of waste obtainable from 400 tons of sisal leaf. To date plots receiving either the total waste or the solid waste have made the fastest growth and they were cut for the first time at 24-27 months from planting. As there are 6,250 plants per hectare yields were higher than usual for a first cutting, namely 1·78 tons per ha. for total waste against 1·94 tons per ha. for solid waste. There is little difference in growth between the sisal treated with liquid waste and the control. Sisal waste has a manurial value in respect of the plant foods which it supplies and in addition it is useful as a mulch for the conservation of soil moisture and protection of topsoil structure. The plants in this experiment tend to be rather etiolated possibly due to the close spacing employed and they have lost colour and "tone" within the last half year. It remains to be seen how long-lasting the effects of the waste will be although it has certainly given the sisal a good start.

Nitrogen Fertilizer Trial.—The purpose of this trial is to test various types of nitrogenous fertilizer in regard to their suitability for sisal. In this experiment sulphate of ammonia, nitrate of soda, calcium nitrate and potassium nitrate are being tried, each with and without phosphate. The rates of application are nil, 50 kgs. and 100 kgs. Nitrogen per hectare and 100 kgs. P_2O_5 per ha. as double superphosphate. Early this year it was found necessary to apply potash to all the plots due to the development of incipient signs of banding disease. During the first year the nitrogen was applied as a single dressing at the onset of the main rains. It was suspected that some of the fertilizer was lost through leaching so this year the dressing was halved but applied on two occasions instead of once with better effect.

The sisal is 20 months old and is showing a clear response to nitrogen. Not only are the plants in the nitrogen plots larger but they have a dark green colour and have grown faster. The effect of phosphate is not so noticeable. As regards the type of fertilizer, calcium nitrate has improved the appearance of the sisal most, there being little difference so far between sulphate of ammonia and nitrate of soda. Potassium nitrate has tended to produce symptoms of chlorotic mottling. Calcium nitrate is very deliquescent and is difficult to use in practice.

Lime Placement Trial.—Light dressings of lime were applied in the row before planting sisal with a view to promoting root formation and thereby hastening growth. Nitrogen and phosphate were applied as well to some plots. The trial is sited on land which was rested for ten years after one cycle of sisal. The soil is therefore in good heart and the young sisal has made excellent growth. Under these circumstances the manurial treatments have had very little effect upon the sisal.

Soil Acidity Trial.—The object of this trial is to elucidate whether chlorotic mottling of sisal is due to a shortage of calcium in the soil or whether it is due to acid soil conditions and the uptake of micronutrients in toxic quantities. Plots were treated with ground limestone or gypsum before planting, and nitrogenous and phosphatic fertilizers were used afterwards. Once again this is young sisal 20 months old but it is showing a good response to nitrogen particularly in the presence of limestone or gypsum. Differences between the two forms of calcium are not great and phosphate has not had any effect upon growth.

Lime Trial.—This experiment was started in 1954 on old sisal land with a view to testing the value of local sources of lime for sisal. The kinds used include (i) finely ground dolomitic limestone frome Kenya; (ii) coarse sievings and dust of crystaline limestone from a stone crushing plant near Tanga; (iii) a soft coral lime from an outcrop on the coast, and (iv) burnt coral lime from Zanzibar. Nitrogen and phosphate were also incorporated in the trial. It is too early to report much although a response to nitrogen is becoming evident.

Spraying Trials—1952 and 1953.—Details of this experiment were given in last year's report. Bulbils have grown faster than suckers but losses of plants due to weevil (*Scyphophorus acupunctatus*) have been slightly heavier, 16·06 per cent compared with 9·2 per cent for suckers. Dieldrin reduced these losses to just over 1 per cent and there is little doubt as to its value for protecting transplants.

Another spraying trial was put down in 1954 using Aldrin as well as Dieldrin on separate plots. Plant losses due to weevil were negligible on the sprayed plots and only amounted to 2·3 per cent in the controls. This is probably attributable to the dry weather restricting weevil breeding and it seems that the benefits of spraying are likely to be greater in wet years than dry ones.

The Station also carried out a bulbil nursery spraying trial using Dieldrin at different strengths and at different times. There were two rates of application, viz. 1·2 lb. and 2·4 lb. active Dieldrin per ha. and spraying was done once soon after planting, once 6 months after planting, and twice, that is after planting and 6 months later. There were twice as many control plots as for any single treatment. Up to the present losses of plants are 18·9 per cent in the untreated plots compared with 7·0 per cent in the case of the low dose and 4·7 per cent for the high dose of Dieldrin, both applied immediately after planting, losses when spraying was done six months after planting are 23.8 and 20·0 per cent respectively for the low and high doses thus indicationg that spraying was too late to be effective. Spraying twice reduced losses to 9.8 and 7·0 per cent for the low and high doses respectively and there was little gained by the second spraying. It would appear from these preliminary results that it is best to use the higher concentration of Dieldrin and to apply this soon after planting. A tractor-mounted spraying machine was used and this was fitted with special booms having jets fixed to suit the rows of bulbils. The spacing in the nursery was also modified to allow the tractor to pass over the ground.

The Station also sprayed three nurseries on outside estates using Dieldrin and the results were satisfactory.

Permanent Bulbil Nursery Trial.—This experiment was repeated for the fifth year in succession and the results were similar to those of former years.

Wide spacing (50 × 25 cms.) resulted in larger plants than narrow spacing (30 × 25 cms.) and the best growth was made on plots treated with 50 tons per ha., of either old or fresh sisal waste.

The trial has been continued this year but an appliction of lime has replaced one of the spacing treatments. At the time of writing the sisal waste plots carry the best plants.

Bulbil Nursery Mulching and Manuring Trial.—Comparison of paper, sisal waste, dried grass and no mulches shows that all the mulches are better than none while sisal waste is easily better than a grass mulch and is a little better than a paper mulch. Liming tended to make for slightly larger plants, likewise using nitrogenous and phosphatic fertilizers but depth of cultivation prior to planting had little effect.

External Trials

Spacing × Cutting Trial—Morogoro District.—After nearly 9½ years this trial was cut out in August since it had almost finished. In most respects the results conform with those of similar trials elsewhere. Yields rise with plant population but the difference between 5,000 and 6,000 plants per ha. was only half a ton per hectare. Spacing between the rows and cutting cycles did not effect yields but they were reduced a little through late commencement of cutting. The general level of yields (15 tons per ha.) was lower than that obtained in trials at Mlingano or Kilosa District.

Grass Rotational × Manurial Trial—Tanga Coast.—Though this trial is over two years old, none of the plots is ready for cutting yet. This is possibly attributable to the nitrogen having been applied indirectly to the grass leys. The experiment is sited on an acidic sandy soil which was treated with lime and N and P fertilizers when it was resting under grass. The sisal has made best growth after the grasses but liming and phosphate have had a bigger effect. Chlorotic mottling and bole rot are common on certain of the unlimed plots particularly those where heavy dressings of sulphate of ammonia were used and the soil is markedly acid.

Grass Rotational × Manurial Trial—Korogwe District.—The layout of this experiment resembles that which is on the Tanga coast. The grasses did not grow very vigorously mainly due to lack of rain and there was not much organic matter to return to the soil when ploughing took place last March. The trial was replanted with sisal which was established successfully but despite fencing the area baboon have caused severe damage to the young plants.

Banding Disease Manurial Trial—Tanga District.—Final results for this trial are available now because the last cutting was taken in July. Potassium applied as 1,100 lb. Sulphate of Potash per ha. during the early stages of the trial raised yields from 12·3 tons to 19·9 tons per ha. This represents a response of 7·3 tons which is highly significant. The cost of the fertilizer amounted to Shs. 37·67 per ton of extra fibre obtained.

Potassium Manurial Trial—Korogwe District.—After a chequered start due to drought and monkey damage, this trial is now fairly well established. Its purpose is to ascertain the optimum quantity of potassic fertilizer to use on areas liable to develop banding disease. Recently disease symptoms have appeared rather suddenly in the majority of the plots of this trial and further dressings are required. A drought is limiting the uptake of fertilizers.

External Exploratory Manurial Trials.—There are eight of these trials in various parts of the Tanga Province and also on the Central Line. The manures under test comprise calcium, nitrogen, phosphorus, potassium and sisal waste.

One trial was cut for the second time and four were cut for the first time during 1954. Yield differences are not very great at the moment and many of the results do not pass the requisite tests for significance. By and large there are responses to waste, lime and nitrogen while potassium dominates the results of one trial, but it is still to early to discuss the effects of fertilizers and different soil types. Baboons have damaged one trial very badly nevertheless it is possible to see big responses to sisal waste and lime. A new manurial trial was started on very acid land in the Korogwe area.

Preliminary Cultivation × Manurial Trial—Kilosa District.—This new experiment is on the site of a former spacing × cutting trial. The land was prepared in three ways for replanting viz: (i) hand weeding of strips; (ii) strip ploughing, and (iii) ploughing the entire area. Up to the present these method have not affected the growth of the young sisal although they had some bearing upon the amount of weeding which was needed afterwards as well as the quantity of grass available for mulching. Ploughing checks weeds and if the entire area is cultivated naturally there is not much material for mulching in the beginning. Other treatments include mulching with sisal waste and using nitrogen and phosphate. The sisal waste has favoured growth. One series of plots will be given an early and light cutting before long since this practice would help in the control of weeds growing in the double rows of sisal.

Plant Physiology

(*E. C. Diekmahns*)

Arrangements were made for the continuation of a sand culture experiment and the collection of leaf samples during the absence of the Plant Physiologist on home leave.

Sand and Water Culture.—The analyses of plants from the replicated sand culture experiment investigating the balance of nutrients necessary for optimum growth was completed early in the year. The statisical analysis of this data is at present being undertaken.

A similar but more comprehensive sand culture experiment than that just described was designed and set up to continue during the year. The observational results at the end of ten months growth show a response to each of the four major plant nutrient treatments—calcium, nitrogen, phosphorus and potassium. As in last year's experiment, the response to nitrogen is the most marked. It is disappointing to report that the only "deficiency symptom" to appear to-date is that of banding disease on several of the plants where potassium is omitted from the nutrient solution.

A water culture experiment using small bulbil plants has been set up to investigate the toxic effect of high concentrations of cobalt and manganese in the presence of varying amounts of iron in the nutrient solution. The plants are rooting well and already after six weeks growth the plants receiving the highest concentration of cobalt are showing the symptoms of chlorotic mottle.

Leaf Analyses.—Leaf samples from the factorial manurial trial and the sisal waste manurial trial were collected from the plots as they came into cut. The analyses of these samples is at present in progress.

During the year leaf samples from plants with various "leaf symptoms" indicative of an upset balance of mineral nutrition were analysed. In addition several leaf analyses were completed in the course of estate advisory work.

Soil Chemistry

(F. Leutenegger)

During 1954 the analytical work for all the samples collected from estates in previous years was completed and the findings were reported to the 38 estates concerned. A preliminary report about ridging water-logged black soils for planting sisal was drawn up and sent to estates having such soils. As regards field trials, special attention was given to a grass rotational × manurial experiment on an acidic red sand soil near the coast and permanent bulbil nursery manurial trial at Mlingano. A trial studying nitrate formation under bare soil and various mulches was sampled every month and analysed immediately in respect of nitrate and ammonia. Profile samples were also collected from this trial in August but the nitrate determinations are not yet complete.

The total number of soil samples collected since 1951 amounts to 2,583, about one third being from estates and two thirds from field trials either on the Station or on estates. All the top-soil samples have been analysed in respect of acidity (pH), total nitrogen, water-soluble, acid-soluble and absorbed phosphate, calcium, potassium and manganessium determinations have been made spectrographically but no work has been done on minor or trace elements except for manganese.

The soils collected have been classified under eleven broad classes or types and large differences in their nutrient status have been found even within one kind of soil. Soil characteristics have also been correlated with the incidence of deficiency diseases of sisal and they tend to be more common on the acid than calcareous types of soil. Analytical data suggests that the exchangeable potassium should amount to 0·3 m.e. per cent for a loamy soil and 0·2 m.e. per cent for a sandy soil and that below these levels banding disease is liable to occur. Sisal prefers a soil rich in calcium with a pH of 6·5 or more. The virgin red earths at Mlingano contain up to 0·2 per cent of total nitrogen or more but after one cycle of sisal this may be reduced to about 0·15 per cent. The phosphorus content of the soils sampled can vary very widely indeed. Some of the best sisal is growing on soils rich in phosphorus but first cycle sisal can grow quite well on red loamy soils, including those at Mlingano which contain rather small amounts of phosphorus. It has been noted that when these soils are manured with sisal waste they possess a much higher phosphorus content and this subject is receiving more attention.

Spectrographic Chemistry

(J. F. Osborne)

Routine analysis of plant and soil samples for bases using the Medium Spectrograph was continued throughout 1954 with only minor interruptions, a total of 31 photographic plates being processed. During the year a second African auxiliary was appointed to the Spectrographic Chemistry Laboratory and received training in the extraction of acetate-soluble bases from soil samples. The senior auxiliary to the Scientific Assistant is now being trained to use the Medium Spectrograph for routine analysis, and in addition to his normal duties he received training for nitrogen and phosphorus determinations.

Plant Analyses.—Analyses of leaves, boles and roots of plants from the 1953 Sand Culture Experiment were completed. Leaf samples collected by the Plant Physiologist from the Sisal Waste Manurial Trial as the plots are cut are being analysed each month. Various leaves showing symptoms of disease, obtained from estates or trials, were analysed and the analysis of plants lifted at the conclusion of the 1953/54 cycle of the Permanent Bulbil Nursery Manurial Trial has started. Some preliminary analyses of sisal waste to determine its fertilizer value were made.

During the year 241 plant samples (209 determinations being duplicated), and 4 samples of flume waste water were examined; this work involved 2,024 element determinations using the Medium Spectrograph.

During the absence of the Plant Physiologist the 1954 Sand Culture Experiment was supervised and 176 determinations each of nitrogen and phosphorus in leaf samples were made.

Soil Analysis.—Further analyses for bases and exchangeable hydrogen were completed on soils from estates (281 samples) bringing this work up to date. It was therefore possible to begin analyses of soils from Station Trials and samples (406) from the following trials were examined.

Permanent Bulbil Nursery Manurial Trial;

Grass Rotational × Manurial Trial, Tanga Coast;

Nitrate Studies Trial;

A few samples of fertilizers and water supplies were tested.

The work listed above involved 5,701 determinations of bases using the Medium Spectrograph and 1,374 determinations of exchangeable hydrogen using the pH meter.

Since the departure of the Soil Chemist on leave the analysis of samples from Nitrate Studies Trial for phosphorus has been supervised.

Plant Breeding.—Certain *A. angustifolia* × *A. amaniensis* hybrids growing at Amani, and others at Mlingano poled during the year and cross pollination work was carried out. About 6,000 seedling plants of previous crosses are growing in nurseries. The majority of the selected hybrids from Amani have proved disappointing when planted in large scale trials, many poling prematurely.

Planter's Day.—The Annual Planter's Day was held on 28th October and was attended by 175 visitors including Sir Geoffrey Clay, C.M.G., Agricultural Adviser to the Secretary of State. The Plant Physiologist was responsible for making all the arrangements for the day and for preparing an exhibit. A talk was also given by the Malariologist, Amani.

Publication and Reports.—Owing to illness of the Senior Research Officer and absence of other staff, it was not possible to issue the usual Half Yearly Progress Report. The Annual Reports for the years 1950, 1951, and 1952 were printed and published during the year while that for 1953 is in the Press.

Malaria Control.—The Station has been assisted by the Malaria Research Unit, Amani, in the application of malaria control measures.

Department of Agriculture and East African Agriculture and Forestry Research Organization.—Four senior grade and four junior grade officers were seconded to the Station by the Department of Agriculture as in the past.

Sir Bernard Keen, F.R.S., Director, East African Agriculture and Forestry Research Organization served on the Research Committee until his resignation due to retirement. Dr. H. C. Pereira has taken his place and visited the Station twice during the year.

The Station continues to afford the East African Agriculture and Forestry Research Organization land and facilities for testing cassava hybrids against mosaic and brown streak diseases.

Acknowledgments.—The Station wishes to thank Messrs. Noorani Plantations, Ltd., for kindly providing decorticating facilities at their Ngomeni and Kitsa Estates whenever required. Thanks are also due to Messrs. Amboni Estates, Ltd., Messrs. Central Line Sisal Estates, Ltd., Messrs. Consolidated Sisal Estates, Ltd., Messrs. Rudewa Estates Ltd., and Messrs. Tungi Ltd., and other estates for their ready co-operation and help on many occasions.

G. W. Lock,
Senior Research Officer

ANNUAL REPORT OF THE ENTOMOLOGIST, MOROGORO, FOR THE YEAR 1954

INTRODUCTION

The writer is mainly concerned with pests of African-grown crops, the assessment of their importance and the devising of techniques to control them which are within the means and capacity of the peasant cultivator. The main problems tackled during the year have been:—

1. The development of a cheap hand duster suitable for peasant-grown crops.
2. The ecology and field control of Maize and Sorghum stalkborers.
3. The bionomics and control of *Helopeltis* bug causing die-back damage to Cashew trees.
4. The Underground Storage of high moisture content maize.
5. Red bollworm on cotton in Southern Tanganyika.

Results and Progress

1. *Insecticide Duster for Peasant Agriculture.*—The cheap, locally-made duster developed by the writer has been extensively tested by E.C.G.C. and E.A.A.F.R.O. entomologists on cotton at Ilonga Experiment Station and has been found to compare very favourably with rotary hand dusters. It is to replace these more expensive machines in future trials owing to its freedom from mechanical troubles and from clogging in conditions of heavy dew. The possibilities of the mass-production of this cheap machine in the United Kingdom are being investigated.

2. *Maize and Sorghum stalk-borers.*—Laboratory work on the Noctuid moth, *Busseola fusca* F., has shown that the larvae are able to withstand extremely dry conditions and absence of food for a considerable period and can then be stimulated by wet conditions to complete development by pupating. This would appear to be an adaptation to climatic conditions prevailing in the Territory where a main wet season is followed by a prolonged dry one after harvest and lends support to the traditional recommendation to remove and destroy all crop residues in advance of the new planting season.

In the Western Province maize and sorghum plants are however left standing after harvest to provide some feeding for cattle during the dry season and it is difficult to see how perfect plant sanitation measures could be enforced. Under these circumstances chemical control using 2·5 per cent D.D.T. dust is being investigated in detailed layouts at Mwanhala Experiment Station and in a number of African plots in the Nzega area. Parallel trials in African agriculture, under the guidance of the writer, but carried out by the Provincial staff, are also being done at Mbeya.

Preliminary results from the Western Province trials show an average of 5·2 damaged plants per 1/10th acre plot in dusted plots five days after the first application compared with an average of 24·4 per plot in the untreated controls. A survey in Nzega, Tabora and Urambo Districts has revealed how-

ever that the incidence of the pest this year is fairly low and it is doubtful whether the control being obtained will result in worthwhile yield increases. It is evident that these experiments will need to be repeated for a number of seasons to decide whether routine dusting would be economic.

3. *Helopeltis on Cashew.*—Investigations on *Helopeltis* were begun last year and have continued in more detail during the present year. Two species of *Helopeltis* have now been found responsible for die-back of young inflorescence stalks and the death of young nuts: these are *Helopeltis* sp. (new species) and *H. bergrothi*, Reut; the latter is capable of causing the more damage, probably on account of its larger size, but in general has not proved so abundant as the new species. The life-history of this latter has now been worked out and its distribution recorded. Further work on the bionomics of both species is planned.

Control of *Helopeltis* bug on small trees has been readily achieved by the application of a 5 per cent D.D.T. plus 0·5 per cent gamma BHC dust with a small portable mechanical duster. A larger machine is being purchased for the next season to investigate the degree of control and yield increase in mature trees up to 30 feet high.

4. *Underground pit-storage of high moisture content maize.*—This is being investigated in experimental pits at the Moshi and Morogoro depots of the Department of Grain Storage. The storage periods at the time of writing are 4 months (Moshi) and 5 weeks (Morogoro) and it is therefore too early to pronounce on the suitability or otherwise of underground storage for damp maize.

The rubberine paint water-vapour barrier used on the pit walls in place of the water-proof cement or bitumastic paint used in previous tests with dry maize (reported on in the Annual Report for 1953) has proved to be very efficient. It is anticipated that this material will be used in all future underground pit storage. Observations are being made on the gas-tightness and durability of the cheaper sealing materials being used in the present trials.

5. *Red bollworm on cotton in Southern Tanganyika.*—Detailed surveys were carried out by the writer in June to advise on the future of cotton growing at Nachingwea in the Southern Province in the light of a heavy infestation by Red bollworm, *Diparopsis castaneum* Hmps. In view of the possible risk to other cotton growing areas, cotton growing at Nachingwea has been discontinued.

A former suggestion that the pest might be able to extend its range northwards by spread on the wild Malvaceous plant *Gossypioides kirkii*, present on the Cretaceous hinterland plateau extending from Southern to Eastern Province, was shown to be very unlikely. Detailed systematic differences have been shown to exist between the Red bollworm larvae on *G. kirkii* and those on cultivated cotton, thus confirming the separate identification on one adult *D. gossypioides* by the Commonwealth Institute of Entomology.

GENERAL

Kapok

Extensive damage on a 1,000 acre plantation of kapok at Kisaki in Eastern Province was caused by adults of the Lamiid beetle, *Tragiscoschema nigroscripta*, Fairm. Serious consideration was given by the owner of the plantation to aerial

spraying against the insect; however the attack was largely spent by the time the writer was called in and extensive chemical control was therefore not advised. Subsequent natural recovery by the trees resulted in an excellent crop later in the season.

Laboratory breeding indicated that the insect produces one generation per year, with a prolonged larval development. Simple petri-dish tests with insecticide dusts against the adults showed the susceptibility to be in the following order:—

2·5 per cent gamma BHC, 0·5 per cent gamma BHC, 5 per cent D.D.T, 2·5 per cent D.D.T, 2·5 per cent Dieldrin.

Sorghum

A heavy infestation of Dobbs sorghum by American bollworm, *Heliothis armigera*, Hbn., occurred at Kongwa in late April; approximately 100 per cent attack was recorded with an average of 6 or more larvae per head of sorghum. Control over 1,500 acres was effected with the "Swaine" duster using 5 per cent D.D.T. in talc at the rate of 6½ lb. per acre. The total costs per acre, including labour, worked out at Shs. 5/-.

Sisal

At the request of H. W. Simmonds, Entomologist, Fiji, preliminary searches were made in the Tanga area for the Histerid beetle, *Placodes ebeninus*, Lewis. which is predatory upon the sisal weevil, *Scyphophorus acupunctatus*, Gyll. The predator is evidently not very abundant, even when a sisal stump is heavily infested with weevil, and the chances of obtaining a strong colony of *Placodes* for despatch to Fiji appear somewhat remote.

Extension Work

A number of talks and demonstrations, particularly on the chemical control of maize and sorghum stalk-borers and stored grain pests, have been given to boys from the nearby Government African Secondary School and to Chiefs and Native Authority staff on training courses at the Local Government School at Mzumbe, Morogoro.

Publications

1. "A Simple and Inexpensive Insecticide Duster". G. Swaine. *E.Afr.Agric.J.* XX. No. 1. 38.
2. "Observations on the Sorghum Shoot Fly." G. Swaine and Catherine A. Wyatt. *E.Afr.Agric.J.* XX. No. 1. 45.
3. "Underground Storage of Maize in Tanganyika". G. Swaine. *E.Afr.Agric.J.* XX. No. 2. 122.

A Review of Entomological work and Progress was written for the Sixth Commonweath Entomological Conference held in London in June.

ACKNOWLEDGMENTS

Assistance has once again been freely given by the Director and Staff of the Commonwealth Institute of Entomology and is gratefully acknowledged.

G. Swaine,
Entomologist

ANNUAL REPORT OF THE ENTOMOLOGIST, LYAMUNGU, FOR THE YEAR 1954

Review.—Much of the time of the Entomologist and African staff has been devoted to the study and control of the White Coffee Borer (*Anthores leuconotus*). The Coffee Board of Tanganyika contributed a sum of money towards the cost of extra staff, transport, equipment and insecticides for extensive field work which is well under way.

A visit was made to the Lake Province hard-coffee growing areas to assess the importance of *Stephanoderes* and to investigate the possibility of effecting control.

In the Northern Province a very extensive outbreak of the American bollworm (*Heliothis armigera*) affected maize and beans and almost every crop grown. D.D.T. sprayed by aircraft saved considerable acreages of beans grown for seed and gave a fair control in maize.

The year as a whole has been one of considerable field activity and consequently collection, museum and laboratory work have unfortunately been neglected.

Coffee

White Coffee Borer.—At Mbozi in the Southern Highlands the last of a series of small scale trials against borer was enumerated at the end of February. The results obtained merely confirmed conclusions from the results of other experiments; namely that Dieldrin is more effective than D.D.T., even on a cost basis. A 1 per cent Dieldrin emulsion sprayed at the rate of *ca.* 200 ml. per tree on the lower 18 inches of the main stem gave approximately an 85 per cent control of larvae.

The large scale trials arranged in the Northern Province with the co-operation of many farmers came to nothing. Very few of the plots were treated at the optimum time or in the correct way. Where farmers had sprayed properly many were satisfied with the results and several plantations have been treated for the 1954/55 season.

Tests with Dieldrin lacquer continued. A full report has been written and will be published in the East African Agricultural Journal. Dieldrin lacquer on coffee trees sprayed 20 months previously still showed definite signs of being insecticidally active although not enough beetles have been available at a convenient time to make a full assessment.

The results justified full scale trials and some fifteen acres of coffee have been treated.

A review of all the data available was made with the help of Mr. P. R. Robinson, Statistician of E.A.A.F.R.O., and a plan of action was formed. The Coffee Board of Tanganyika was approached and the Board decided to accept and finance the whole scheme which is an attempt to elucidate the optimum amount of insecticide needed to effect a satisfactory control, and to study the biology of the pest at varying altitudes and localities.

The programme is summarised briefly below:—

(1) Large scale trials on the chemical control of borer covering a total of 150 acres of coffee on 14 different farms are being made in the Moshi and Arusha Districts. Dieldrin emulsion and Dieldrin lacquer are the two formulations used. A hundred acres of coffee have been sprayed with four concentrations of Dieldrin emulsion. Fifteen of twenty-five acres have been treated with Dieldrin lacquer, but the other ten acres have had to be temporarily abandoned owing to shipping delays of the materials.

(2) A monthly survey at varying altitudes and localities has been undertaken to determine accurately beetle emergence periods and other details of the borer life-cycle.

(3) A very brief survey of the wild host trees of borer has shown that the trees are still very numerous in many coffee-growing areas. Moreover these trees harbour considerable numbers of beetles.

A survey will be made wherever possible and the possibility of destroying the trees chemically is being considered.

(4) New chemicals were tested and compared with insecticides now in use against borer. Much of this work is being carried out by the C.I.R.U., Arusha. Present indications are that Endrin is of similar toxicity to Dieldrin and that D.D.T. is of similar toxicity to Chlordane. Dieldrin and Endrin are significantly better than D.D.T. and Chlordane. The technique used consists of applying droplets of a known size of a solution of each insecticide in an inert oil from a micropipette to mouthparts and tarsi of female beetles.

(5) The correlation of stem temperatures and length of life-cycle of borer is being carried out. Temperatures of shaded and unshaded trees have been recorded at two altitudes since August. Data will also be obtained by breeding borer in constant temperature cages in the laboratory.

Control of Antestia with "Swingfog".—A further attempt was made to control *Antestia lineaticollis* with the "Swingfog" applicator. Tests were made in heavily infested coffee.

Treatments—1. Dieldrin—200 gm. of technical Dieldrin dissolved in $1\frac{1}{2}$ litres RM 1011 (Shell) per acre.

2. D.D.T.—200 gm. of technical D.D.T. dissolved in $1\frac{1}{4}$ litres RM 1011 per acre.

Each of the treatments extended over one acre of coffee and was not replicated. The fog drifted satisfactorily through the plots. When estimating population marginal trees were ignored.

Results:—	*Dieldrin Plot*	*D.D.T. Plot*
Before treatment	4·3 Antestia per tree	4·3 Antestia per tree
24 hrs. after treatment	0·8 Antestia per tree	1·3 Antestia per tree
48 hrs. after treatment	0·7 Antestia per tree	1·6 Antestia per tree
72 hrs. after treatment	0·8 Antestia per tree	1·2 Antestia per tree
5 days after treatment	0·6 Antestia per tree	1·0 Antestia per tree
7 days after treatment	1·0 Antestia per tree	1·3 Antestia per tree

The control effected was not satisfactory as the maximum tolerance level of 0·3 Antestia per tree was not reached. This tolerance level is purely arbitrary, but has been proved to be a suitable one for most purposes.

From these figures it would appear that the fog is only effective if it comes in direct contact with the insect at the time of application. The fact that the population remains fairly constant after the first 24 hours after application suggest that the fog leaves no considerable residue.

An attempt was made to show whether these conclusions were correct and the chemical staff of the C.I.R.U., Arusha, collaborated in making a further trial. The following formula was used:—

Solvent RM 1011	- 1 litre
D.D.T. 95-99 per cent pp	- 200 grms
Pyrethrum concentrate 25 per cent	- 10 c.c.

Waxoline red was included to mark deposits on glass plates. The pyrethrum was included in the fog to agitate the Antestia and so induce them to contact more of the fog as is the case with mosquitoes. This amount treated 300 trees, just over half an acre of coffee. The fog on this occasion behaved very badly and tended to drift up into the shade trees with the result that the coffee was exposed to the fog for comparatively short periods. An anemometer showed that the air was almost still.

Results:—

Before spraying	4·0 Antestia per tree
18 hrs. after application	2·5 Antestia per tree
4 days after application	2·8 Antestia per tree

As the field results were unsatisfactory no further laboratory work in assessing residues on the plots was carried out.

In the laboratory Antestia was exposed to a fog of 20 per cent D.D.T. and 1 per cent pyrethrum in RM 1011 for approximately $\frac{1}{2}$ minute. Half of the Antestia were knocked down but nearly all of these recovered, the total mortality being negligible.

Numerous other similar experiments were carried out including 1·5 per cent pyrethrum in RM 1011. No useful results were obtained and the "Swingfog" applicator was set aside as being unsuitable for controlling Antestia in plantations.

Leaf-miner (*Leucoptera coffeella*).—Many outbreaks of leaf-miner have occurred on coffee farms. In some cases oubreaks appeared earlier than usual with the result that a high proportion of the crop on affected trees never ripened.

Some experiments of a preliminary nature have been carried out sporadically as time permitted in an attempt to control the miners within the leaf.

The insecticides used were Metasystox, Chlorothion and Folidol (parathion) supplied by Farbenfabriken Bayer. These organo-phosphorous insecticides are said to be safe to handle.

Early laboratory experiments suggested that Chlorothion was more effective than Metasystox, but later experiments showed that weight for weight Metasystox was significantly better than Chlorothion, the kill given by the Chlorothion not being significantly better than control. It was also shown that 0·05 per cent Folidol emulsion was better than 0·05 per cent Metasystox, the difference being highly significant. It would be as well to note that a great deal of conflicting data has been obtained and that results are by no means final. Folidol, however, has always been the most effective insecticide.

It has also been found that Folidol was more effective if applied to the underside of the leaves than to the upper leaf surfaces.

Limited field experiments using Metasystox and Chlorothion at approximately 100 gallons/acre of 0·1 per cent active ingredient gave 75-82 per cent kill with Metasystox and 75-87 per cent kill with Chlorothion compared with 25-38 per cent dead larvae found in the controls, presumbly due to parasite activity. The insecticides did not appear to persist for more than a few days. No field tests were made with Folidol.

Unfortunately both insecticides gave a slight but consistent taint to coffee picked within a few days and several weeks after spraying. Coffee taken from control trees gave a clean liquor in five cases and a very slight taint in the sixth.

The taint cannot be given a definite description except that it is of a chemical nature. It is not possible to say whether the taint is likely to affect the market value of the crop.

It is proposed to continue with the insecticidal trials against the leaf-miners and also to investigate the possibility of importing additional parasites in an attempt at biological control, which, if successful, may be more suitable for the farmer.

Stephanoderes.—A visit was paid to the hard-coffee areas in the Lake Province to review present position of *Stephanoderes hampei* and to consider the possibility of effecting a suitable chemical control.

It was found that little real attempt to control the pest by collecting fallen cherry was made. Natural factors were completely ineffective in keeping the loss of crop to negligible proportions. Stephanoderes is almost ubiquitous but in some areas as much as 40 per cent of the green cherry was affected by the beetle while in other areas damage was negligible. The incidence of the pest is undoubtedly influenced by climate. Coffee in the Lake shore area and the vales is more heavily infested than that in the hills.

An Instructor was sent to Bukoba District during the main picking seasons of the year to estimate as far as possible the amount of coffee destroyed by Stephanoderes and other coffee pests. He visited the main co-operative collecting centres and took samples of dry cherry from each. Those centres showing a fairly high incidence of the pest as a result of the first count were revisited 2, 3 or 4 times during the season. It is not yet possible to assess the loss in full but it can be said that about 10 per cent of all cherry collected from fifteen of the worst affected areas were attacked by Stephanoderes. Furthermore another 20 per cent of the cherry had been attacked by berry moth caterpillars, believed to be mainly *Thliptoceros octoguttalis* and *Deudorix* sp. That is 30 per cent of the gathered crop had been insect damaged. This does not necessarily mean a thirty per cent loss of crop as some of the affected cherry may contain sound beans. On the other hand the loss of cherry by insects before harvesting must be considerable.

Temperatures under Wound Dressings.—Temperatures of the wood of coffee 1 mm. below wound dressings were taken at the hottest time of the year (January—mid-March). It was found that under black bitumen, the wound dressing in general use, temperatures reached 60°C, under white lead paint 46·5°C, under aluminium paint 50°C and in wood without dressing 45°C.

These observations comprised part of the work carried out on the Coffee Research Station on wound treatment.

Maize

American bollworm (*Heliothis armigera*).—In most districts very heavy infestation of *Heliothis* was found in maize, especially in some of the higher areas where maize had been planted with early rains. The infestation was noted soon after silking and the attack intensified as the cobs filled. In one field it was estimated that 89-96 thousand caterpillars were living in each acre of maize, but the overall average for the farm was probably about 46 thousand per acre. The infestation in late-planted maize was considerably less than this.

In view of the severity of the attack it was decided to spray the maize by aircraft applying 12 oz. of actual D.D.T. per acre in 2 gallons of emulsion. The results were as follows:—

Number of Heliothis on 50 Plants

	1st instar	2nd instar	3rd instar	4th instar	5th instar	instar instar
Before spraying	29	13	36	67	23	52
48 hours after spraying	1	1	1	6	17	19

After spraying it was estimated that the Heliothis population was reduced to 12-13 thousand per acre.

At first sight it would appear that the younger instars were more susceptible to D.D.T. than the later instars. This was not necessarily the case as it was found that all those which survived the treatment were in fact feeding within the cob and therefore were protected from the spray. As many as five or six dead larvae could be found lying on each square yard of soil in an area with a high infestation of caterpillars.

An analysis of residual D.D.T. on maize foliage made by the C.I.R.U., was found to be less than 2 mg. per square foot. Eggs found on late planted maize at the time of spraying hatched normally and the young caterpillars were apparently completely unaffected by the residue. It is not known how the D.D.T. affected the moths.

Attempts were also made in controlling Heliothis by the individual treatment of cobs by hand. It was found that if a 5 per cent D.D.T. powder was dusted on the silks with a paint brush a fair degree of protection was obtained. This method proved to be inpracticable over large acreages especially in tall white maize.

The infestation of caterpillars was eventually lessened by natural factors, including parasites and disease, throughout the district before much damage was caused to the main-crop maize planted in late March.

An attempt was made to estimate the loss of crop caused by the caterpillars on early planted maize, but many factors including ear-rot and early cessation of the rains made it quite impossible. The total loss of actual grain was consiered to be small, but the quality was somewhat adversely affected. It is considered that the loss of crop due to ear-rot in the caterpillar-damaged cobs would have been severe had rains not ceased prematurely.

The cause of this unusual outbreak is not known.

Seed Dressings

Maize.—The need for seed dressings in protecting dry planted maize seed against soil-living insects was briefly discussed in Annual Report for 1952. This year two similar experiments were laid down on two different farms.

Treatments included an untreated control, "Fernasan A" (containing TMTD fungicide only), "Fernasan B" and "Fernasan C" and an experimental seed dressing of TMTD plus lindane. Thus the last three treatments contained TMTD plus increasing amounts of lindane.

Each experiment covered approximately one acre of land. The treatments were randomised and replicated six times. On one farm the seeds were planted mechanically in rows at the rate of six seeds per yard. On the other farm seeds were planted four per hole, holes being at approximately one yard intervals.

In each case the seeds lay three weeks in the soil before there was rain enough for germination.

The results were assessed by counting the number of plants which germinated and reached ankle height successfully in each treatment. On the first farm there were no significant differences between treatments and control. The germination was satisfactory in each case. On the second farm all treatments were significantly better than control, but there were no differences between the treatments. Germination in 'Control' was slightly more than half of the germination rate in each of the treatments. The loss of seed in controls was due in part to chafers.

It would appear that TMTD acts as an insect repellent since the dressing containing no insecticide was as effective as those containing insecticide.

Barley.—Trials against *Cydnus* spp. (Cydnidae) attacking wheat and barley came to nothing as Cydnus did not appear in considerable numbers either in control or treatments. It was established, however, that the soil-living larvae of *Phoromitus gravidus* Gerrt. (Curculionidae) was capable of doing very considerable damage. On the farm in question Phoromitus caused extensive damage and the seed dressings against Cydnus, 20 oz. of Mergamma B (containing lindane) per 200 lb. seed, and 20 oz. of Aldrin 25 per cent Wettable Powder per 200 lb. seed were completely ineffective. The beetle larvae in this case, however, did more damage at the tiller stage than at the seedling stage.

Phoromitus can always be found in wheat and barley fields. This year the outbreak in the lower areas was more severe than usual.

Root-Knot Eelworms

Several cases of eelworm attack were noted throughout the year, particularly in potatoes. It was also noted that in the declining papaw fields where the plots were deteriorating to the "small-head" condition, the roots were very badly affected by root-knot eelworms. It is not known whether the eelworm is an important factor in causing the "small-head" condition which is generally acknowledged to be due to drought and starvation of the plant.

Sugar

A sugar-cane borer, *Eldana saccharina* Wlk. (Pyralidae) has been recorded for the first time in Tanganyika. It was causing severe damage in mature cane and causing dead-heart in new shoots arising from "seed" in a small estate about 20 miles SSE. of Arusha. This farm produces jaggery for local consumption. The amount of cane which can be treated daily is small and consequently much

of the cane is left standing in the field long after it is mature until it can be dealt with. This together with the practice of cutting cane above ground, not burning the cane before cutting, and in the use of a variety of soft cane almost certainly gave rise to the heavy infestation (cf. Dick J.—Some data on the Biology of the Sugar-cane borer, South African Sugar Technologists Association, 1945).

The borer is being controlled by planting harder varieties of cane and in adjusting cultural methods.

An inspection on Tanganyika's main sugar-estate 35 miles away suggested that *E. saccharina* is present in very small numbers, one small living caterpillar being found as well as a few bored stems.

Apantules sesamiae Cam (Braconidae) was recorded as a parasite of *E. saccharina*.

Beans

Farmers growing seed beans for export have had to contend with very serious outbreaks of insect pests. Mr. A. J. Jones, Entomologist, covered this field of activity until July when he returned to the United Kingdom.

The following account is virtually his own summary:—

American bollworm caterpillars (*Heliothis armigera*) appeared in even larger numbers than in 1953, and caused considerable damage to maize, sorghum and beans. It would appear that the American bollworm has become an established pest in the Northern Province.

The caterpillars were first noticed in sorghum and were seen to feed on the seed when it had reached the milky stage, but the more mature hardening seed was not attacked. The infestation in sorghum was more widespread than was at first realised, and subsequently the services of an air spray unit were engaged.

An experimental spraying was first carried out on a heavily infested block of sorghum, having an average caterpillar population of six per head. The area was sprayed during ideal air conditions in the late evening. Using a 36 foot swathe width, the aircraft sprayed approximately $\frac{1}{2}$ lb. of D.D.T. in approximately 2 gallons of emulsion per acre. A population survey was again carried out in the area three days after the spraying, and it was found to be reduced to 0·4 caterpillars per plant, i.e. approximately a 95 per cent reduction. It was observed that the small to medium sized caterpillars were easily killed, but the large caterpillars were more resistant.

In maize, the caterpillars were found to be feeding on the seeds at the tips of the cobs. They were also burrowing into the cob via the green husks and eating areas of seed below.

The attack on beans followed later, when the plants were bearing fully grown green pods. It seems that the American bollworm moth is attracted to the bean flowers, and lays her eggs on the plant at this stage. This then would explain the apparent excellent timing of the caterpillars for, while very young, they feed on the bean leaves and, when older, feed on the fully formed and developing pods.

The possibility of an aerial spray penetrating the foliage mass and reaching the undersides of the bean leaves in such a good growth year as this was viewed with extreme doubt. A trial was, therefore, arranged, with the co-operation of the C.I.R.U., to find whether droplets could penetrate the bean foliage. Paper sheets and magnesium oxide plates were laid in an area of bean plants, both

beneath the plants and in the open, and the area was sprayed in the late evening with a D.D.T. emulsion containing a red dye. The results obtained were as follows:—

Using 33′ swathe width and 1/16th″ jet orifices, giving droplet sizes of average diameter 156 microns;

70-80 per cent of the emulsion was recovered in the open;

35-40 per cent of the emulsion was recovered under the plants and between the rows;

10-15 per cent of the emulsion was recovered on the pods.

Since it was found that the droplets did actually penetrate the canopy of foliage, and that the average size of the droplets recovered there was approximately 150 microns diameter, it was considered worth carrying on to do a biological test.

A heavily infested fields was then surveyed and a caterpillar population of 163 thousand per acre of mostly small and medium sizes was recorded. The area was then sprayed in the late evening, using a 36 foot swathe width and approximately ½ lb. D.D.T./acre. A population estimate taken three days after the spraying revealed a reduction to 43 thousand per acre, mostly full grown caterpillars.

A tractor mounted sprayer fitted with a boom and drop-legs also gave a good control of bean pests, using ¾ lb. actual D.D.T. per acre in 10-15 gallons of water. This year, however, it was found that the foliage was so thick that damage was not only caused by the tractor wheels moving between the rows, but also by the drop-legs becoming entangled with foliage and uprooting plants.

Dusting has also been tried with some success, but this has its limitations in so far that air conditions are not always suitable, and that suitable imported dusts are rather expensive.

(Some loss of crop did occur as a result of caterpillar activity. In the main, however, it would appear that the kill obtained by spraying followed by some control by natural factors reduced this loss to small proportions of total crops. No figures are available-RGT).

ACKNOWLEDGMENTS

I have drawn freely on the knowledge and experience of others too numerous to mention individually. I am particularly indebted to A. P. G. Michelmore, Senior Entomologist of the Uganda Department of Agriculture, P. R. Robinson, Statistician of E.A.A.F.R.O., and to many of the Staff of the Colonial Insecticide Research Unit; the Commonwealth Institute of Entomology has continued to identify insects and other materials.

I am grateful to Dr. H. G. H. Kearns of Long Ashton who has shown interest in our spraying systems and who is actively experimenting in improving apparatus and techniques both for the peasant and the estate farmer.

I am indebted to Messrs. Farbenfabriken Bayer, Pest Control, Plant Protection, Shell Chemicals and the Pyrethrum Board of Kenya for a supply of insecticides for experimental work.

Mr. R. O. Bowley has been seconded from Messrs. Plant Protection to the Coffee Board for field work on borer research since September, 1954.

R. G. Tapley,
Entomologist

ANNUAL REPORT OF THE PLANT PATHOLOGIST, LYAMUNGU, MOSHI, FOR THE YEAR 1954

Staff

The Staff of the Plant Pathology laboratory, Lyamungu, has continued the same as in 1953, i.e. Mr. G. B. Wallace, Plant Pathologist, and Mrs. M. M. Wallace, Temporary Scientific Assistant. Mr. N. B. Joy, Plant Pathologist, was stationed at Arusha; he has prepared a separate report, but has given valuable assistance in some of the investigations recorded in the present report. The work of my two African Laboratory Assistants has continued satisfactorily; Mr. Basil A. Kalisti was on vacation leave for three months.

Acknowledgments

Once again it is a pleasant duty to acknowledge the invaluable collaboration of authorities abroad, and also that of my colleagues in the Department of Agriculture. The Director and Staff of the Commonwealth Mycological Institute, Kew, and Dr. W. J. Dowson of Cambridge have provided or confirmed identifications of a number of fungus and bacterial organisms. Dr. W. J. Zaumeyer of Beltsville, Md., U.S.A. and Dr. W. L. Gordon of Winnipeg, Canada, have assisted in the identification of bean diseases and of Fusaria respectively.

Visitors

Among visitors to the laboratory were several members of the Commonwealth Parliamentary Association Conference; Sir Geoffrey Clay, Agricultural Advisor to the Secretary of State; Dr. D. Rhind, Secretary of the Colonial Agricultural Research Council; The Hon. the Director of Agriculture and the Acting Deputy Director of Agriculture, Dar es Salaam; Dr. H. G. H. Kearns, Long Ashton, and Dr. G. V. Jacks, Rothamsted, England; Prof. and Mrs. Moule and Mr. P. Sluis, California; Mr. S. Y. Sluis and Mr. F. Alewijn, Holland; Dr. E. A. Riley, Plant Pathologist, Northern Rhodesia; Mr. I. A. S. Gibson, Forest Mycologist, Kenya.

Touring

I visited Chambezi, Morogoro, and the Southern Highlands Province during February and the Arusha District on several occasions. Five meetings of the Tanganyika Seeds Board were attended by invitation.

Publications

Mycological Circular No. 35 was prepared in May, and No. 36 in August. The former is an "Index to References to Plant Diseases in Laboratory Publications", while the other is the eighteenth issue of "Recent Records".

Laboratory Work

Over 440 specimens of plants have been examined for disease; 17 have new records of disease for Tanganyika, while 13 are new local host records for diseases known in the Territory. In the course of laboratory investigations 219 isolations

in culture were made. Cultures of nodule bacteria for legume seed inoculation were provided as required. The Cowpea strain was obtained through the courtesy of Dr. R. M. Nattrass, Kenya.

A number of specimens of plant diseases and of fungus cultures have been identified for the Forest Department, Kenya, and the Overseas Food Corporation in Tanganyika. Disease in coffee specimens from Nyasaland proved to be Bark Disease, the parasite being obtained in culture.

At the Agricultural Show in Moshi in September, a number of plant diseases were demonstrated; the interest shown, particularly by African growers, is worthy of special mention.

A demonstration of plant diseases was given to members of the Agricultural Department attending a course in Soil Conservation at Tengeru, and another on coffee diseases to the staff of the Coffee Research Station.

Some of the diseases to which references have been made in previous reports and which were not recorded during the past year are as follows: Bacterial blight of peas has not been seen in 1953 or 1954 and it is likely that the culture of seed peas for export could be safely resumed, even if only on a limited scale for a time. Kromnek of tobacco, which was first observed in Tanganyika in one plant in 1947, increased till 1950 when it was probably present on every farm in the Iringa District. Its apparent non-recurrence in the past four years may be a result of greater attention to the destruction of tobacco refuse at the end of each growing season. It has not been found here on any plant other than tobacco (unless possibly the sunflower virus is the same, as was at first thought to be the case). The virus disease found in sunflower on one farm in 1947 has not been seen again. Although all infected plants were destroyed as they were found, it was not expected that the disease would disappear, but that would seem to have occurred. The non-appearance this year of papaw Scab (*Sphaceloma* sp. nov.), which was recorded on one farm in 1953 is thought to be a result of dry weather, and of efforts to reduce humidity among the trees by reduction of wind breaks and the suppression of weeds.

In a few other cases the absence of records this year could be a result of the disappearance of diseases, but it is likely that in the majority of cases the explanation is insufficient inspections.

Banana.—While continued watchfulness for new outbreaks of Panama disease, or Wilt, is necessary, methods for its suppression are now established routine in the few endemic areas. There are still no more than six varieties found to be susceptible in the trials on infected land near Moshi. The fruit of some of the varieties which were brought in from other districts or from neighbouring Territories for trial are proving popular and these will be multiplied for distribution. Land for multiplication of healthy material of introduced varieties has been made available through the courtesy of the Prisons department at Moshi. Necessary expenses in connection with the banana work are still being met by the Chagga Council.

A severe form of Cigar-end rot, caused by *Verticillium* (*Stachylidium*) *theobromae* is not unusual in the Kilimanjaro variety Nlelembo. In this variety whole fingers, and not merely the tips, are rotted; most of the damage takes place in the period July to October. The closely related variety Nshonowa is resistant and is often used to replace Nlelembo where a cooking variety is required. The variety Nshonowa has an additional advantage to the African grower:

the terminal bud on the fruit stalk is chopped and added to the fruit when making beer, in order to give it an additional kick. The bark of the indigenous tree *Rauvolfia inebrians* is used for the same purpose.

The variety Nlelembo is also peculiar in often having a form of wilt, which is apparently non-parasitic. About half of the older leaves die prematurely and hang down. While this must affect the weight of fruit, the immediate effect is to reduce the amount of leaves available for cattle food.

Beans.—Bean diseases are discussed in the report of the Plant Pathologist Arusha.

Cashew.—Investigations are in hand into a disease in cashew which is causing some anxiety near Lindi. Two fungi have been isolated from roots and trunk bases—*Botryodiplodia theobromae*, and a species of *Cytonaema* closely related to the pycnidial stage of *Valsa eugeniae*, which is regarded by Nutman and Roberts as the cause of the clove Sudden Death. To date no parithecia of the second cashew fungus have been found. It is too early yet to say if the similarity of the two diseases is more than superficial.

Coffee.—Coffee plantations in the Usambara Mountains were visited and a report was made to growers. The frequent failure of the trees is ascribed to shallow, poor, acid, eroded soil.

The Bark disease, first described by Dr. H. H. Storey, and the Scaly bark disease are being further studied. The former is common in the Usambaras but mild elsewhere. The Fusarium parasites which have been identified from the two diseases are technically strains of the same species.

Rots from cut surfaces of coffee stems and twigs are being given increasing attention at the Coffee Research Station and on plantations. A paint is being sought which will meet the requirement of effectively keeping out rot organisms for a long period, and which is cheap. A number of paints are under trial by the Agricultural Officer, Lyamungu.

Cotton.—Fusarium wilt, with characteristic symptoms, was fairly severe in localised plots in the Lake Province. The fungus was isolated in culture from material observed and collected by M. H. Arnold, Scientific Officer of the E.C.G.C., Ukiriguru, and the identification confirmed as *Fusarium oxysporum* f. *vasinfectum*. Its pathogenicity was proved by inoculation into cotton seedlings in the laboratory. This is the first positive record of the disease since 1904 when it was found by Zimmermann near Mombo.

Herbaceous ornamentals.—Bacterial diseases were found in three species of flowering plants in two gardens at Lyamungu. The bacteria were isolated; they are important since they were found to be infective to various economic crop plants. The identifications of the organisms were made by Dr. W. J. Dowson.

Xanthomonas campestris var. *armoraciae* (McCulloch) Starr and Burkholder, strain, was found in candytuft. In addition to candytuft, other Cruciferae found susceptible to inoculation by a culture of the bacteria were horse-radish, cauliflower and cabbage.

Bacterium carotovorum var. *atrosepticum* Helmers and Dowson was isolated from diseased Larkspur and Schizanthus in the two gardens. This organism is the cause of Blackleg in potato, although that crop has not so far been seen infected in the field in Tanganyika. The Larkspur bacteria isolated were infective

to their original host species and to potato. The Schizanthus isolation was tested on various plants and was found infective to its original host species and to potato, tomato, tobacco, Petunia, *Capsicum annuum*, *Physalis peruviana* and the indigenous weed *Nicandra physaloides*. Among thirteen garden plants not found susceptible were groundnut and French bean.

Indigenous plant.—The bacteria causing a form of Halo blight in the indigenous plant *Neorautanenia pseudopachyrhiza* is stated by Dr. Dowson to correspond to *Pseudomonas primulae*. It is not infective to French bean.

Maize.—Head smut has been recorded as severe in places. Much more attention should be given to rotation; where, as is usual, there is a land shortage, and rotation is impracticable, infected tassels and ears should be removed early to prevent build-up of infection from spores falling to the ground.

Polysora rust was severe on the coastal plain and at Mahenge, Morogoro and Kilosa. It was observed by the Plant Pathologist, Arusha, in that District for the first time, and was present but mild in the Moshi District.

Brown spot (*Physoderma maydis*) was again present in the Moshi District, but was of no economic importance.

Pineapple.—In the early part of the year pineapples for canning showed a 30 per cent loss on account of a dark brown rot involving large areas below the skin. Externally there was no sign of disease. Three species of bacteria were isolated, but two of these proved to be saprophytic organisms; the third died in culture. It is now thought that the tissue degeneration may be a result of boron deficiency, and a trial is in hand to investigate that possibility.

Pines.—In 1953 the fungus *Cylindrocarpon radicicola* was isolated from roots of unthrifty seedlings of *Pinus radiata* from the Southern Highlands Province. As this fungus has the reputation of causing casualties in seedbeds of pine in Europe, it was tested in *P. radiata* seedlings at the laboratory. However the inoculation was made, no reaction was obtained, indicating that the fungus is not a primary parasite of *P. radiata*. This experiment was repeated with the same result by the Mycologist, Forest department, Kenya, to whom a culture was given.

Potato.—Irish blight was less severe than usual on account of the dry season. The Blight Form "H" (International "2") previously recorded in the potato variety 1,792a (13) was found at Lushoto in 1,790a (2) and in 1,673b (4). Form "C" (International "2,4") is now in variety 1,899a (1).

Sisal.—A leaf spot of sisal occurring near Korogwe and also near Amani was investigated. This differed from any condition previously seen on sisal. The spots were round, brown with a rough, often cracked surface, and were commoner on the under surface. Most crops had a minute puncture at the centre, suggesting insect damage. Isolations from the lesions produced several weakly parasitic fungi, but no one of these was obtained consistently from all spots. None of the organisms isolated reproduced the spots when inoculated into young sisal leaves at the laboratory. Further work is necessary.

Sorghum.—Sorghum smuts are referred to by the Plant Pathologist, Arusha.

Sugar cane.—The virus disease Ratoon stunting was observed in two localities—near Moshi, and at Chambezi on the coast. The identifications were confirmed by Dr. H. H. Storey. Tests for control of the virus in planting material by heat treatment are being carried out at Muguga in Kenya.

Tomato.—The two most serious diseases this year have been a bacterial rot on a half-acre field, and Gray leaf spot on a large plantation where the fruit is grown for canning.

(1) The bacterial disease is caused by a variety of *Bacterium carotovorum*, probably *atrosepticum*, according to Dowson. The symptoms are similar to those of Brown rot (*Pseudomonos solanacearum*), previously recorded in the Territory in Solanaceous crops. The plants responded well to control measures and there was little loss of crop. A culture was infective to tomato and egg plant, and it rotted slices of potato, though not slices of turnip or carrot nor the rind of citrus fruits.

(2) The Gray leaf spot, caused by the fungus *Stempylium solani* had not been recorded previously in East Africa. It has a history of destructiveness elsewhere. As it does not respond to the common copper fungicides, trials with Dithane Z-78 are being undertaken. Seeds of seven resistant varieties have been obtained from Hawaii, through the courtesy of the University of Hawaii College of Agriculture.

(3) Calcium deficiency was indicated by the very common Blossom-end rot, particularly in the canning variety San Marzano, and in some plants by other less usual but more intense symptoms. The latter show in the younger foliage at the top of the plants: leaves remain small and become yellow and brown with purple veins; flowers do not develop or they produce no fruit. The top of the plant wilts and dies prematurely.

(4) Irish blight in tomato was less common on account of the dry season. The form "I" (International "3,4") was identified by Dr. W. Black. (See also potato on previous page).

Trees.—In the Iringa, Mufindi and Njombe areas of the Southern Highlands Province there is fairly serious disease in wattle and eucalyptus. Plantations were examined during a short visit in February, and a report on observations was distributed to those concerned. The subject was referred to in Mycological Circular No. 36. Several attempts at Lyamungu and elsewhere to isolate organism which might be responsible have failed. The disease in eucalyptus was most severe outside Iringa in soil consisting almost entirely of sand to a depth of at least ten feet; eucalyptus growing on a sandy spit beside a lake was also severely affected. Only young trees of wattle are affected, and it is tentatively suggested that there is a layer of defective soil below the surface. The Government Chemist is examining the soil aspect.

Wheat.—Stem rust forms found in tests at the laboratory with material collected at Ol Joro, Arusha, were K1 and K14; at Ol Molog, K10 and K14; and at Ngare Nairobi K9, K12 and K14.

The leaf spot caused by *Pyrenophora tritici-repentis* was found for the first time in Tanganyika. The more serious foot rot form of the disease was not seen and the perithecial stage of the fungus was not observed in the field, but was obtained in cultures made from leaf infections.

REPORTS FROM THE PROVINCES ON PLANT DISEASES

Provincial officers have kindly sent reports on the disease situation during the year, and the following notes have been abstracted with some comments. In all Provinces diseases have been comparatively mild, chiefly on account of the dry weather during most months.

Southern Highlands.—The most serious diseases have been Hemileia in coffee, Stem rust in African-grown wheat, and Irish blight in potatoes. Spraying is being encouraged against Hemileia. The wheat and potato diseases should decrease in future years as the susceptible varieties are gradually replaced by resistant strains. This applies also in the case of cassava Mosaic, for which resistant Amani varieties are being multiplied and distributed as rapidly as possible. The only reference to tobacco diseases is that Mosaic was fairly widespread in small quantities and never serious; there seems little doubt that the attention to uprooting and burning of tobacco refuse at the end of each season is proving effective.

Among legumes, Halo blight and Mosaic were present but not serious in French beans; in peas Mildew was present but no more serious than usual. Head smut was seen in maize and sorghum; the early destruction of affected plants, if continued more intensively, should reduce this disease very considerably. Die-back of wattle and cankering in eucalyptus are dealt with separately.

A considerable degree of control can be obtained with a number of diseases by cultural measures, and these are often the only practicable measures particularly with African-grown crops. Increasing advantage is being taken of the knowledge on this aspect of control throughout the Province.

Eastern and Central Provinces.—Widespread infection of sorghum with Head smut is reported from Mahenge District; Grain smut was less common; maize was heavily attacked by Polysora rust in the coastal districts and in the Morogoro and Kilosa Districts. The incidence of the latter has been much more widespread than in the previous years. Late-planted maize suffered most, whilst short-rains maize appeared to escape attack; these observations bear out the general experience.

Southern Province.—The disease causing most concern by the end of the year is that in cashew, referred to separately. Polysora rust was again present in maize.

Northern and Tanga Provinces.—Since many of the observations by the field staff in these Provinces were made in collaboration with the laboratory staff they are incorporated in the general report on diseases.

Western Province.—Rosette of groundnut was mild this year and only the late plantings were infected to any considerable degree. A sorghum smut was very prevalent, but the identity is not recorded. Cassava Mosaic was moderate, the variety Lliongo being more heavily infected than the sweet varieties.

FUNGI, ETC., NEW TO TANGANYIKA

Banana	*Helminthosporium bicolor* Mitra.
Candytuft	*Xanthomonas campestris* var. *armoraciae* (McCulloch) Starr & Burkholder
Cashew	*Ceratocystis* sp.
Cashew	*Cytonaema* sp.
Cassia sp.	*Gliocladium roseum* Bain
Cotton	*Fusarium oxysporum* Schl. f. *vasinfectum* (Atk.) Snyder & Hansen.
Larkspur	*Bacterium carotovorum* var. *atrosepticum* Hellmers & Dowson
Podocarpus	*Corynelia uberata* Fr.
Salvia leucantha	*Corynespora cassiicola* (Berk. & Curt.) Wei.
Schizanthus pinnatus	*Bacterium carotovorum* var. *atrosepticum*

Sugar cane	Ratoon stunting virus
Timber	*Paecilomyces variota* Bainier
Tomato	*Bacterium carotovorum* prob. var. *atrosepticum*
Tomato	*Stemphylium solani* Weber
Wheat	*Cladosporium macrocarpum* Preuss
Wheat	*Erysiphe graminis* D.C.
Wheat	*Pyrenophora tritici-repentis* (Diedicke ex Drechsler) Drechsler

NEW HOSTS OF PATHOGENS ALREADY RECORDED IN TANGANYIKA

Asparagus	*Fusarium oxysporum* Schl.
Banana	*Fusarium solani* (Mart.) App. & Wr.
Banana	*Verticillium* sp.
Bean, velvet	*Corticium solani* (Prill. & Delacr.) Bourd. and Galz.
Candytuft	*Sclerotium rolfsii* Sacc.
Cotton	*Macrophomina phaseoli* (Maubl.) Ashby
Digitaria spp.	*Piricularia grisea* Sacc.
Groundnut	*Colletotrichum capsici* group
Hibiscus cannabinus	*Leveillula taurica* (Lév.) Arn.
Peppermint	*Corticium solani*
Petunia	*Fusarium solani*
Stock	*Sclerotinia sclerotiorum* (Lib.) de Bary
Violet	*Sclerotium rolfsii*

GEO. B. WALLACE,
Plant Pathologist

ANNUAL REPORT OF THE PLANT PATHOLOGIST, ARUSHA, FOR THE YEAR 1954

Staff

The Plant Pathology Laboratory, Arusha, was established on 1st January. Mr. N. B. Joy, Plant Pathologist, was on duty throughout the year. One laboratory assistant, Mr. Harton F. Mtega, was also on duty.

Review

Much of the writer's time has been spent in collecting together equipment and in other activities necessary to a new laboratory; disease and herbarium specimens have been collected for demonstration purposes. Apart from this, the writer has been concerned mainly with dwarf beans and their diseases, germination and disease testing, and the collection of material for future experimentation.

Touring

The Plant Pathologist, Arusha, paid short visits to the Plant Pathology Laboratory, Lyamungu, on a number of occasions. The Babati, Oldeani, Essimingor and Ol Molog areas were visited in connection with a dwarf bean survey.

Meetings of the Tanganyika Seeds Board were attended by invitation in March, May, July, September and November.

Dwarf Bean Survey

A survey of the diseases of this crop was made during the months of May to August. Over 7,000 acres were inspected in the Kilimanjaro, Arusha, Essimingor, Oldeani and Babati areas.

The climate was wetter than in the 1953 season in most districts, although the distribution was not always favourable. One or two areas, it appears, have experienced much colder spells than is usual. These conditions, while resulting in more vigorous crops, have produced a different disease picture from 1953 with respect to the relative importance of the various diseases.

Taken as a whole, disease of dwarf beans has been more severe than in 1953; the wetter weather was probably partly the cause of this. This year the relative economic importance of the three most serious diseases has been in the following descending order—Halo blight (*Pseudomonas phaseolicola*), Anthracnose (*Colletotrichum lindemuthianum*) and common bean Mosaic.

Very few of the fields inspected were found to be free from these diseases and in many all three were noted. In older areas of cultivation Halo blight and anthracnose were found in about 50 per cent of the fields inspected, and in some fields there was virtually 100 per cent infection. It seems fairly certain that these two diseases are gradually increasing, and are building up widespread reservoirs of infection through soil contamination. Instances of dust-borne infections of Halo blight were observed (as were in 1953, by the Plant Pathologist, Lyamungu), and this method of spread is a factor to be reckoned with, especially where new

land is taken into cultivation on the leeward side of already contaminated soil. The maximum effective distance of dust-borne infection can only be guessed at; the farthest distance observed this year was about 600 yards.

The common bean Mosaic was noted for the extreme variations in symptom picture displayed, even within small areas under one variety. The presence of strains is indicated, and it is hoped to separate and isolate these; five quite different symptom pictures were recorded. The aphid vectors of this Mosaic were not noticed this year.

Mosaic was often found to cause stunting and subsequent loss of crop. Anthracnose frequently caused the death of plants in badly infected patches, this being the result of seed-borne and early secondary infections (see below under Dwarf Bean Experiments); later secondary infections appeared to have little effect on the general vigour of the plant. In contrast to these, Halo blight, even where there was virtually 100 per cent infection, did not often appear to be lethal. This was assumed to be due to the fact that, by the time disease had developed, the plants were older and the dry season had set in, thus preventing the pathogen from becoming too virulent. However, seed infection through the pods never appeared to be hindered by the dry weather.

The wetter conditions brought Sclerotinia rot (*Sclerotinia sclerotiorum*) into prominence; it was very destructive in certain limited areas. Spells of cold weather appear to favour its development.

Rust (*Uromyces appendiculatus*) appeared too late in the season to be of any significance and only in isolated cases was it at all severe. Its occurrence was often obviously influenced by the different susceptibilities of the various varieties in use.

Other diseases noted, but nowhere serious, were Angular leaf spot (*Isariopsis griseola*), White mould (*Hyalodendron album*), "Sunscald" and a bronzing and necrosis thought to be due to mineral deficiency.

Dwarf Bean Experiments

Small scale trials were made with the systemic fungicide Streptomycin, to test its use in the field against Halo blight. A 0·1 per cent solution was used and the results agreed with other reports that the therapeutic properties of this antibiotic are limited. But when it can be obtained at an economical rate for its practical application, this fungicide promises to be valuable as a prophylactic to be used in conjunction with roguing.

Preliminary investigations into the transmission of the common bean Mosaic virus were carried out. Carborundum powder was used as an abrasive for inoculations but no transmission was obtained; growth conditions were not good.

Certain points of interest were revealed in connection with disease testing methods. Bean plants were raised from seed infected with Halo blight. It was found that disease did not always develop in the plants; whether it does so or not appears to depend upon conditions of growth. Also the length of time the disease takes to appear (Incubation Period) varies considerably. In one trial, where seven out of twelve plants developed the disease, it first appeared only after a period of seven weeks and two days from the date of planting.

The severity of Anthracnose at the seedling stage was demonstrated by planting out in the long rains seedlings with diseased cotyledons; many quickly developed stem lesions causing the subsequent death of the plant.

It was shown that Anthracnose spores carried externally on seeds constitute a possible source of infection when the seeds are planted. From forty seeds treated with a heavy suspension of spores and planted in sterile soil, three of the seedlings developed disease. The lesions on the cotyledons were found indistinguishable from those resulting from internal seed-borne infections.

Germination Tests

Thirty-six tests of seed samples were made for growers: thirty-four of dwarf beans, one of lettuce and one of maize. Of the samples of seed representative of crops grown in Tanganyika, all had a germination capacity (percentage normal seedlings) of over 80 per cent and most of over 90 per cent. All figures would have been above 90 per cent had there not been in some cases mechanical damage (shown superficially as cracked seed coats) to the seed, resulting in "baldheads" in the germination trays. Cracked seed coats and moisture wrinkling were the most common seed defects seen in samples. Certain of these seed defects were tested for their affect on subsequent germination. The defects tested were cracked seed coats, moisture wrinkling, wrinkling due to insect attack and Yeast spot (*Nematospora coryli*). All the seeds used were taken from the same variety and sample. The seeds were germinated in sterilised sand, and the following results were obtained :—

Seed type	*Germination Capacity*
Normal	88 per cent
Cracked coats	28 „ „
Moisture wrinkles	64 „ „
Insect wrinkles	72 „ „
Yeast spot	36 „ „

In the case of the seeds with cracked coats 56 per cent were viable, but 50 per cent of these suffered from "baldhead" symptoms (the result of internal damage). As the various defects tested vary in intensity, the figures in the table above must not be taken as accurate quantitative comparisons.

An experiment was carried out to compare laboratory and field germination figures, so as to facilitate field interpretation of laboratory results. The field soil was virgin volcanic ash, well watered; the laboratory substrate sterilised sand in trays. Six dwarf bean varieties were tested, giving the following results:—

Variety	*Laboratory Germ. Capacity*	*Field Germ. Capacity*
1	100 per cent ...	86 per cent
2	99 „ „ ...	86 „ „
3	98 „ „ ...	85 „ „
4	82 „ „ ...	61 „ „
5	82 „ „ ...	52 „ „
6	43 „ „ ...	20 „ „

As the results show, the lower the germination capacity the greater the discrepancy between laboratory and field figures.

Samples of Mauritius Thorn (*Caesalpinia decapetala* (Roth) Alston) seed were found difficult to germinate. In an effort to increase their germination, twelve different treatments were tried, including scarification, heating in water, treatment with sulphuric acid, sodium hydroxide and potassium nitrate; by far the most successful was temporary dry heat—by burning three sheets of ordinary brown paper over the seed.

The purity of samples received was very good, but live Bruchid beetles and weevils were seen in one or two bean samples.

Disease Tests

Twenty-nine seed samples were tested for growers, for the presence of Halo blight, Anthracnose and Mosaic. Anthracnose was often found, as it was in a number of germination tests; in one sample 24 per cent of the seed were found to be infected. Halo blight and Mosaic were not observed, probably because of the unavoidably unsatisfactory methods used. Improved testing methods for these two diseases are being investigated. The presence of Anthracnose in many samples of imported seed shows that this disease is definitely being brought into Tanganyika. It is fairly certain that Halo blight and Mosaic are also being imported from an inspection of growing crops on virgin land. The only way of preventing this is for growers to provide their own stock seed from fields they know to be clean, or to quarantine imported stock seed for one season.

Maize

In the Arusha District, the commonest diseases were Pink ear rot (mainly *Fusarium graminearum*), Head smut (*Sphacelotheca reiliana*), Streak virus and Rust (*Puccinia sorghi*). Pink ear rot was the most serious disease and the only one found to be very intensive, e.g. a loss of seed estimated at 30 per cent was suffered in one case. The influence of rainfall on the severity of this disease was obvious.

Smut was only observed in African owned fields, and in one or two places it caused considerable damage.

Streak virus disease was widespread in certain areas, but nowhere was it seen to occur in more than 10 per cent of the plants.

Rust was the most extensive disease of all, but it never appeared to be very virulent.

A yellowing and dwarfing of maize in the Arusha area, after trials with fertilisers and trace elements, was thought to be due to the presence of a hard pan below soil surface.

Coffee

A yellowing and necrosis of the leaves gave concern to growers this year. Fertiliser and trace element trials were started on one farm, but results so far have been negative.

Coffee beans were inoculated with *Aspergillus niger* by pricking and spraying. It was thought that this fungus might be operative in causing the condition known as "corky pulp". Although the fungus grew readily enough on the beans, it remains doubtful if it is the cause of "corky pulp".

Sorghum

An outbreak of Grain smut (*Sphacelotheca sorghi*) in the Arusha area caused considerable loss of seed. By using the fact that smutted grain floated in water, measures for seed cleaning were devised to separate them from the unaffected (internally) grain.

Acknowledgments

Grateful acknowledgment is made to the Plant Pathologist, Lyamungu, for every assistance given in establishing this laboratory and for continued help during the year. Also to the Director of the Colonial Insecticide Research Unit, Arusha, for the provision of laboratory accommodation. The East African Agricultural and Forestry Research Organisation Herbarium staff at the Coryndon Museum, Nairobi, kindly identified a number of plants.

N. B. Joy,
Plant Pathologist

ANNUAL REPORT OF THE BOTANIST, UKIRIGURU, 1953-54 SEASON

General.—The bulk of the sorghums at Ukiriguru had been dry planted by 14th October. Rainfall was as follows :—

TABLE I

October	14th	...	0·20″
	15th	...	0·73″
	20th	...	0·47″
	28th	...	0·29″
	31st	...	0·12″
November	14th	...	0·56″
	19th	...	0·06″
	28th-30th	...	1·03″
December	Ample, well distributed.		

The germination was good, estimated at 80 per cent on 20th October. The rainfall was barely sufficient between then and 28th November, but the majority of the sorghum hung on, and grew away on the December rain. Some replanting was necessary, but on the whole the crop looked well.

Borer was evident in the early plantings, but not unusually severe. A second planting in February-March, in fields about ½ mile away from other sorghums, was successful, Central Shoot Fly not being serious; although many of the plants did not germinate until early April. Sorghum planted at the same time close to existing stands was heavily attacked by the fly.

A—Sorghum Breeding

The objectives of the breeding work have been detailed in previous reports: briefly, early maturing varieties which combine good yield with weevil resistant palatable grains are being developed, and an attempt is being made to incorporate a degree of resistance to bird attack.

(1) *SUK.* 1. Mention was made in the last report of BCWK3, a segregate from the first cross of B.C. 27 (3½ months, poor grain) × Wiru (5-6 months, palatable weevil resistant grain). This variety was re-named SUK. 1, and distributed for observation and trial: it combines earliness of maturity with a Wiru type grain, but appeared to give only average yields, and to be susceptible to grain smut: it is liable to severe bird damage.

The yields from this variety were better than expected, although they varied a good deal from place to place. Bulk yields were as follows :—

	Area	Yield in lb./acre	
Lubaga	½ acre	... 2,100	
Ukiriguru	2 acres	... 930	
Songea	¼ acre	... 400	(Local type harvested 3 weeks later gave 530 lb./acre).
Mwanhala	1/20 acre	... 150	(Dobbs gave 510 lb./acre).

General observations from elsewhere in the Territory were :—

Loljoro (Arusha). Not as good as Oklahoma for yield, the head being small, but it merits further consideration.

Mahenge. Six weeks earlier than local varieties: good quality grain: yield would have been good but for extensive bird damage: some grain smut.

Extracts from trials were as follows :—

TABLE II

SUKUMALAND

Yields in lb./acre

	Lubaga	Butulwa	Kitunga	Mabuki	Ilula	Mean for all plots
SUK. 1	1,580	585	270	710	325	685
B.C. 27	1,455	505	180	380	210	540
Dobbs	745	890	235	480	190	510
Bukura Mahemba	830	565	285	1,040	475	640
L.S.D. P = .05	250	110	N.S.	105	45	—

MAHIWA

SUK. 1	965 lb./acre
Caprock	370 lb./acre
Combine Waxy Kaffir	325 lb./acre

The yields in Sukumaland were governed by the rain: at Kitunga the sorghum established with difficulty and then endured a long dry spell: Mabuki established well, but suffered from drought, the rain coming too late to increase the yield of the early varieties: the first planting at Ilula was taken by Quail, and the second planting encountered difficult weather: Butulwa was rather dry for part of the season: the Lubaga rainfall was sufficient and well distributed for early varieties, but drought affected the Dobbs and Bukura Mahemba.

These results are encouraging: SUK. 1 has stood up well in storage tests, and the local people regard it as very palatable: at least in this season it has given an acceptable level of yield in several areas, where conditions were reasonable. Definite progress can thus be reported, in that an early maturing variety with a weevil resistant, palatable grain, capable of giving a satisfactory yield, has been produced.

Resistance to bird damage and to grain smut now need to be added.

(2) *Backcrosses for weevil resistance, grain mould resistance, and better yield.* The F4 progeny rows of the (B.C. 27) 2 × Wiru cross looked most promising on the mbuga, containing many strong plants with good heads and grains. 192 selections were taken from them, together with some from F4 bulks at Ukiriguru and Lubaga of the same cross. 125 selections were taken from an F3 generation, and 109 selections from an F2 generation of the same (B.C. 27) 2 × Wiru cross, which has been made twice. Grain quality in the (B.C. 27) 3 × Wiru F2 generation was disappointing, but 61 plants were taken for progeny rows.

The back-crossing of B.C. 27 and Wiru has now been carried far enough and strains with the same good grain as SUK. 1, but better yield, are coming out from these crosses.

Grain mould.—Help in breeding for grain mould resistance has most kindly been offered by Dr. Keay of Makerere. Material was sent to Makerere, and Dr. Keay is going to develop techniques for culturing the moulds and infecting the grain, which will be of the greatest assistance.

Msumbiji crosses.—The Msumbiji crosses have been continued: the Msumbiji grain has a high reputation for palatability and weevil resistance, and may have a measure of grain mould resistance. The absence of purple pigment in the plant results in a grain of much cleaner appearance than Wiru, the latter often being marred by purple spots.

One hundred and ninety-five early maturing plants with Msumbiji type grain were selected from the F2 generation of the cross (BC. 27) 2 × Msumbiji, and 8 heads from the best F3 plants of this cross were crossed with good F5 plants of the (B.C. 27) 2 × Wiru. The F1 generation of this cross (B.C. 27) 2 Msumbiji × (B.C. 27) 2 Wiru was grown successfully in the greenhouse, and the F2 generation will be grown in the 1954-55 season.

There was an indication that, during very dry weather, plants of the Msumbiji type without the purple pigment may be more liable to Aphis attack, and possibly also to borer.

Other crosses.—200 early maturing plants with good grains were selected from the F2 generation of the cross Dobbs 2 × Wiru: Dobbs matures in about $4\frac{1}{4}$ months, and is a vigorous, high yielding variety. Small quantities of other crosses between early maturing parents and late maturing, good grained types such as Belko, Nkwe and Ushiriki receive attention as time permits.

(3) *Bird resistance*.—An outline of the factors affecting bird damage, and the birds concerned, was given in last year's report. Figures of birds caught in basket traps were as follows :—

TABLE III

Month	Dioch	Sparrow	Other grain eaters
January, 1954 ...	—	—	—
February	—	—	—
March	—	—	—
April	—	—	—
May	—	—	6
June	—	—	6
July	50	17	90
August	100	—	91
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

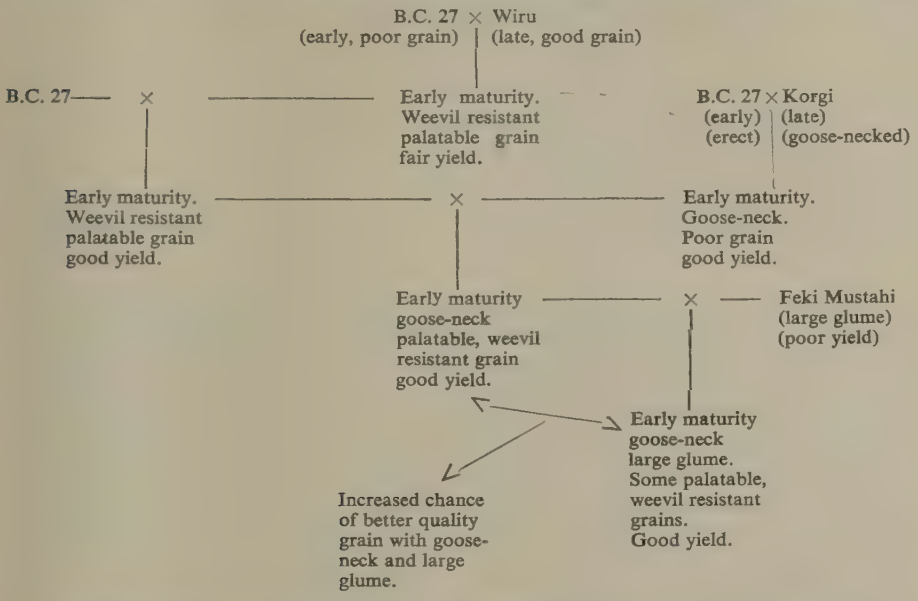
The trapping is not very efficient, and does not give a reliable sample of the grain-eating bird population: last year's trapping showed Dioch as present in some numbers in March, July-August, and November-December. This year they were abundant July-August only.

An inverted head (goose-neck), and large glumes are the main characters being transferred to the early maturing sorghums in the hope that they may confer a measure of bird resistance: some attention is also being given to awns.

Goose-neck.—The crosses of (B.C. 27) 2 × Wiru segregates, with goose-necked early maturing Korgi and Ng'holongo crosses, continued well. Over 100 F1 rows were grown in the nursery at the beginning of the season, and harvested in time to allow of 470 selected plants being grown as progeny rows for another generation. From these, 239 plants with goose-necks were selected, of which 11 had good corneous layers in the endosperm, and 72 had medium corneous layers.

Other lines of B.C. 27 × Korgi and Ng'holongo, and Oklahoma 44/14 × Korgi and Ng'holongo, are being continued: it is too early to comment on the difficulties of working with the goose-neck character, but several lines consisted of only goose-necked plants in the F4 generation.

Large glumes.—The crosses with Feki Mustahi to transfer large glumes to early maturing parents have also proceeded well. Eighteen crosses were made to various early maturing goose-necked lines, and to B.C. 27. The F1 generations were grown, and from these plants, 44 back-crosses to the early maturing parents were made. The following diagram may clarify this part of the programme:—



A large glume has appeared in segregates from the cross (B.C. 27 × D.D. Shallu) × (B.C.27 × Wiru): the plants of this particular line are quite good, the and grain is reasonable, so this will be crossed to some of the best (B.C. 27) 2 × Wiru lines.

Awns.—The progeny from the cross and back-cross of B.C. 27 with Nandayal Poona have been carried on, and some early maturing lines have good awns and short stiff seed branches, from the latter parent. These have not yet been crossed to the (B.C. 27) 2 × Wiru weevil resistant material.

(4) *Large grain.*—Work has also continued with the large grained segregates form B.C. 27 and Oklahoma 44/14 crosses with Korgi.

Comments on the crossing programme

Now that SUK. 1 has shown some promise, attention is being concentrated on adding bird resistance to relatives of similar parentage and grain characters, but better yield. It should be possible before long to assess the extent to which bird resistance can be conferred on to a palatable grain by protective characters such as an inverted head, large glumes, and awns. Crosses to confer grain smut and grain mould resistance to the SUK. 1 are also being planned.

(5) *Striga*.—Selection continues within the Dobbs lines which show a degree of Striga resistance, but this season the Striga attack was light and assessment difficult.

(6) *Reference collection*.—The number of self-pollinated varieties maintained here was reduced to 94, the discarded varieties being put into the mixed bulks.

B—Experimental

(1) *Storage tests*.—A test was done on 6 varieties, using the usual 100 grains in net bags technique: results are shown in table IV.

TABLE IV

Period 20/8/54 to 11/12/54 6 replications

Variety	Mean % loss
SUK. 1	7·5
Bukura Mahemba...	14·0
B.C. 27	20·0
Ng'holongo	20·0
Dobbs	20·5
Wiru	26·5
L.S.D. (·05)	7·5

For the first time since these tests were commenced in 1949 Wiru has stored badly, and Ng'holongo was no better than Dobbs. The only difference in technique was the treating of the grain before the tests with "Kiloptera" to destroy any grain moths present. As this is volatile, and the grain was spread in the sun after treatment, its effects should not have persisted. Differences are more likely to lie in the ripening conditions of the grain: SUK. 1, B.C. 27, and Dobbs ripened in the March drought: Bukura Mahemba just after the rains: but Wiru and Ng'holongo had received such a check in February-March that they ripened well after the rains, when Lygus were very active, and the Ng'holongo showed two thirds of Lygus damaged grain. The Wiru sample looked quite good, and there was no obvious reason why it should have gone down so badly, especially as SUK. 1 is of the same grain type.

Preliminary trials were done with small bulk storage tests, 10 lb. of grain being placed in a petrol tin, and 100 weevils introduced. The samples had been treated with Kiloptera before starting the test, and the tins were covered with sacking during the tests: in spite of this, moth (*Sitotroga*) built up in large numbers in several tins. Again, losses were not as expected:—

TABLE V

(Means from first 2 replications not affected by moth)

Variety	% of damaged grain
B.C. 27	3
SUK. 1	5
Wiru	8
Bukura Mahemba ...	12
Dobbs	14
Ng'holongo	43

The B.C. 27 loss is very low, the other unexpected figure being that for Ng'holongo. In the latter case, it seems that weevil built up in the matrix of Lygus damaged grain. The method of doing storage tests on small bulks needs consideration: and evidently only clean sound grain should be used.

Striga.—The amount of Striga in the district plots was generally low, and the counts were insufficient to show any differences, with the exception of the Lubaga trial, figures from which are in Table VI.

TABLE VI

	Striga plants per acre
SUK. 1	165
B.C. 27	195
Dobbs	135
Bukura Mahemba ...	3,085

Figures are not worth analysing, but do suggest that SUK. 1 is no more susceptible to Striga than the other two early maturing varieties.

Rice

General.—The New pump has made a lot of difference to the water supply at Mwabagole: in spite of only 2″ of rain in February and 0·5″ in March, transplanting was carried on from late-January throughout February, and about 10 acres of material was kept growing in March by pumped water. Yields were satisfactory, trials giving 2,000—4,000 lb. per acre, which was good for the type of season.

(2) *Selection and Experimental*.—As mentioned in the last report, selection work has been suspended until the large number of strains from previous years has been properly examined. Progeny observation plots of 142 strains were planted for study, and a further 93 strains were put into 5 balanced lattices.

The objectives were strains with as good or better yield as Kahogo, better straw strength, less tendency to shed, and at least as good quality. It looks as though a few selections possess a combination of all these characters, and quite a number possess a combination of two, under Mwabagole growing conditions.

Five separate small trials proved more satisfactory in practice than one or two large ones: the Arab and African staff at Mwabagole have to do a lot of the trial work themselves, and find smaller numbers of strains per trial easier to handle: mistakes matter less (although these are commendably few), as perhaps only one trial may be affected. The fact that there is no real comparison between strains in different trials is not important, since the best strains from each trial go together in a further trial in the following season.

C.—Acknowledgments

I am indebted to many members of the Department for help during the year, especially the growing of, and reporting on, sorghum strains in many different areas: to the E.C.G.C. staff here for much interest and advice: to the Farm Manager and his associates for most competent handling of the field side: and to Professor Fergus Wilson for agreeing to the help being given by Dr. Keray.

H. Doggett,

Botanist

ANNUAL REPORT OF THE FISHERIES OFFICER (FISH FARMING) FOR 1954

1. Korogwe Experimental Station

No further ponds were constructed during the year at the Experimental Station. The lay out now consists of 27 ponds in all—8 fry ponds, 6 breeding ponds, 9 production ponds and 4 rice ponds. It is considered that these are adequate for the needs of the Territory for the time being and fulfil the following objectives:—

(a) To supply fry to the public for stocking purposes of all waters in the Territory with six different species suitable for the particular local environment.

(b) To acquire information on yields in production ponds.

(c) To carry out experiments.

(d) To train African instructors in fishery technique.

(e) To act as a demonstration ground for potential fish farmers.

(f) To assist the Medical Department in the biological control of bilharzia and malaria by means of fish.

2. Rice Ponds

The orthodox rice-cum-fish experiments of previous years were repeated this year, although a disappointingly small yield of rice was obtained.

Some useful information was acquired on what can be done to produce fish in shallow ponds. In the "control" rice pond (in which rice was not planted) the following figures were attained.

Area	0·76 acres
Stocking	300 fingerlings T. melanopleura 300 fingerlings T. nilotica
Date of Stocking...	5/10/54
Date of Harvesting	14/1/55
Yield	269 lb.

This pond is only 1 foot deep with a small sump hole 2 feet deep for draining purposes and to give the fish some place of refuge from predatory birds.

3. Extension Work

There is no abatement in the very considerable public interest in fish and applications for the supply of fry for stocking purposes continue to come in from all parts of the Territory. It is the policy that every piece of water should be stocked with fish—even if later the grown fish are poached. A typical example of this was the stocking of Lake Kindai, Singida District over a year ago. During the drought this huge lake gradually dried up and the shallow water made promiscuous fishing easy. The District Commissioner reported that an immense quantity of fish was obtained by the local inhabitants.

Consignments of fry were sent to the following districts during the year; Mwanza, Kongwa, Arusha, Moshi, Manyoni, Kilosa, Dodoma, Iringa, Muheza, Tanga, Pangani, Njombe, Mufindi, Ngomeni and Usa River.

Some 250 pamphlets on fish farming (Fisheries Pamphlet No. 2) have been distributed during the year as the result of enquiries from the public. The need has been felt for a new pamphlet also giving the statistical and economic side of fish farming. Such a pamphlet has been prepared and is now in the press.

4. Instruction and Visitors

Courses have been held at Korogwe from time to time for the training of African instructors.

Distinguished visitors included Sir Geoffrey Clay, Agricultural Adviser to the Secretary of State, the Director of Agriculture, and a party of African chiefs from the Uluguru District.

5. Contact with other African Territories

In February the Fisheries Officer in Charge on local leave visited Zanzibar, Madagascar, Reunion and Mauritius as a result of this visit the Government of Mauritius is sending an Instructor to Korogwe for a course of training.

Requests for pamphlets and information have also been received from the Governments of the Sudan and Gold Coast. Both of these territories were visited by the Fisheries Officer in Charge in 1952.

6. Co-operation with Medical Department

The East African Fisheries Research Organization, Jinja, has discovered that several of the species of *Haplochromis* and related Cichlidae consume vast quantities of the snails which are host of the bilharzia parasite. Notably among these is the *Astatoreochromis alluaudi* which in addition to its snail-eating propensity grows to a fair sized excellent eating fish. Breeding stock of this species has been introduced to Korogwe and early in the New Year fry should be available. It is proposed to organize a wide scale scheme of distribution in conjunction with the medical authorities, so that every piece of water in the Territory which is suspect of bilharzia should receive its quota of these fish.

7. Revenue

Revenue received during the year was Shs. 3,788.86 i.e. about the same as last year.

R. E. Gould,
Fisheries Officer in Charge,
Fish Farming

ANNUAL REPORT OF THE FISHERIES OFFICER (MARINE) FOR 1954

The year started with high hopes that at long last the work of the Marine Fisheries Unit could go ahead without delay. This, unfortunately, was not to be, due to a series of mechanical faults in M.F.V. *Patoni*. Another disappointment was the failure to obtain a suitable site for the establishment of the fisheries base. However, some information of value has been obtained from the too infrequent trips of M.F.V. *Patoni* and also concerning the supply and distribution of fish in Dar es Salaam.

The refitting of M.F.V. *Patoni* was completed in February and she put to sea for the first time during the month. The main engine broke down within twelve hours of leaving Dar es Salaam so no fishing was possible. The main engine has given trouble ever since, with the result that only thirty days were spent at sea during the year, including the time taken getting to and from the fishing grounds. The amount of time spent fishing was, therefore, exceedingly short.

In view of the fact that the crew had had no experience of handling a boat like *Patoni* nor of European fishing methods, it was considered advisable to fish with hand lines only in the first place. Three trips were made to the waters at the southern end of Mafia during July, August and September. Fishing was carried out on the Vulture Bank and on a three fathom bank, as yet unnamed, in the vicinity of the Ras Mkumbi lighthouse. These banks consist of coral and are very small in area. The banks were first marked by buoys and when the ship had steamed off for a short distance, she was allowed to drift over the banks while the crew fished with lines. It soon became apparent that fish were only to be caught immediately over the coral and that if the ship drifted past the banks no fish were caught. This seems to suggest that the most desirable species of bottom fishes, the *Lutianidae*, *Lethrinidae* and *Empinephalidae* are very restricted in their distribution. No other means of fishing over coral has yet been devised which is superior to the hand line in such conditions.

Trawling was attempted on three occasions; the first occasion being in July in the Rufiji delta, the second off Ras Mkumbi at Mafia in August and the third time in 80 fathoms off Dar es Salaam. On no occasion was trawling a success. The gear fished well but only one or two fish were caught mostly of taxonomic interest. The echo-sounder on M.F.V. *Patoni* is very efficient and in areas where trawling is possible no fish have been located. It is possible to steam for many miles without getting any traces of fish. Large wooden bobbins bound with iron have now been fitted to the footrope of the trawl and it is now possible to fish over rougher ground but engine trouble has prevented a full trial being made.

While most of the year's efforts have gone into trying to get M.F.V. *Patoni* to sea, some information has been collected about the supply and distribution of fish in Dar es Salaam. Fresh fish is supplied from all the surrounding villages from Unonio, twenty miles to the north, to Mboamaji ten miles to the south. The number of fishermen in the main fishing areas is estimated as follows:—

Mjimwema and Mboamaji	...	...	...	100
Msasani	...	...	...	200
Dar es Salaam and Magogoni	...	...	...	300
Kunduchi	...	...	...	60
Unonio	...	...	...	75
Other Villages	...	...	...	50
			Total ...	785

The allocation of crew to each boat is three on an average. Two fish while one rests. Most of the fishermen live all the year round in their villages but during the South East monsoon Arabs from Zanzibar come over bringing their own crews for the "Kingfish season". This lasts for about six months when they return to Zanzibar. Very few of the fishermen own their own boats and gear. The native owners of the boats in Kunduchi and Unonio are usually relatives of the crew, but in the other villages most of the owners live in Dar es Salaam. There are very few non-native resident owners. There is one Arab boat owner at Msasani who has prospered in recent years and now owns about fifteen boats and in addition buys fish from other boats at Msasani. The fishermen do not seem to have any desire to own their own boats as they do not cherish the idea of maintaining their boat and fishing gear. The proceeds of the catch are usually divided as follows:— one half to the owner, the other half between the crew. The owner puts aside one quarter of his share for upkeep and maintenance of the boat and gear.

The number of fishermen has declined slightly in recent years. A large number of men, despite the high prices paid for fish, find it better to work in Dar es Salaam then to go fishing. The present high cost of equipment is another deterrent.

A small quantity of the fish caught is retained by the fishermen for their own use or is sold direct to the consumer with or without the owner's knowledge. Normally, however, the fish reach the public through middlemen who buy the fish at the villages and sell it elsewhere later. The majority of middlemen take the fish to Kariakoo market where it is sold on the auction. At Msasani a smaller proportion goes to the market as the village is conveniently near to the European houses at Oyster Bay, where some middlemen sell direct to the consumers. Hotels also absorb a fair proportion of the Msasani catch.

Any attempt to estimate the amount of fish sold in Dar es Salaam is made extremely difficult by the practice of selling fish not by weight but by bargaining. The current prices of fish can be safely assessed at cents 60 per lb. to the producer, 1/- per lb. to the middleman and 1/50 to 2/- per lb. to the retailer. The big differences in these prices has led to the main market at Kariakoo being by-passed as many of the middlemen sell direct to hotels and other catering establishments as well as selling round the houses, thus making roughly 1/- per lb. profit. In addition he has no market dues to pay.

The weight of fish sold at Kariakoo market cannot be estimated accurately as the fish are not sold by weight but a fair estimate would be 250,000 lb. per annum including dried fish. This is a very small amount and is obviously only a small part of the total which is sold in Dar es Salaam in a year. It is virtually impossible with the facilities available at the moment to estimate what the exact proportion of the total this figure represents.

The year has been most frustrating in many ways, but it is sincerely to be hoped that before another twelve months have passed the ship will be operating faultlessly and doing useful work and that the much needed Fisheries Base will be in existence.

D. J. WATSON,
Fisheries Officer (Marine)

EXPERIMENTAL WORK CARRIED OUT BY THE SOIL CONSERVATION SERVICE DURING 1954

Experiments on different methods of hand cultivation on steep hillsides were continued for the fifth year and results very similar to those of previous years were obtained. A full description of these results was published in last year's report and it is not proposed to repeat the figures given there. Once again, yields from the "Matengo Pit" system proved superior to all others, and those from bench terraces in any form were definitely inferior to those from any other method of cultivation, including that with no conservation measures at all.

Work begun last year on the "first year effect" was continued and it was verified that second year crops of maize are probably better than first year crops after virgin grassland and after a Rhodes Grass ley, although the difference between measured yields did not quite reach statistical significance. These difference were however substantial—Over 30 per cent. Dressing with sulphate of ammonia (2 cwts. per acre) increases yields of maize in both the first and second years after breaking from grass, but the increase is significantly greater in the second year as compared with the first. Increased intensity of cultivations from two preliminary cultivations to three also increases yields with a significantly greater increase in the second year as compared with the first. If the relatively low yields in the first year after grass are due to immobilization of nitrogen by bacterial decomposition of raw organic matter, the differential response to additional nitrogen and to increased intensity of cultivation is difficult to explain unless the bacterial breakdown of organic matter in tropical soils is a much slower process than is often believed.

A series of experiments on the effect on a succeeding maize crop of maize stover incorporated into the soil at various times prior to planting and also used as a surface mulch was carried out with some very interesting results. Previous experiments (described in last year's annual report) were fully confirmed in that it was conclusively shown that maize stover in the form of a surface mulch severely reduced crop growth and yields, at least to as great an extent as does maize stover dug into the soil. The earlier stover was ploughed in, the less was the depressing effect which was patently due to nitrogen immobilization, but the depressing effect of a surface mulch can only be explained on the assumption that mineralization of nitrogen is largely a surface phenomenon, and that nitrate, which is easily demonstrated as accumulating in the surface soil, is immobilized just as easily, if not more so, by a surface mulch as it is by incorporated stover.

As part of the experiments on mulch, one treatment was incorporated in which woven papyrus matting creosoted on the underside was laid on the surface with holes cut in it for maize to grow through. It was thought that this treatment would give the equivalent immobilization effect of mulch without the biological effects. This treatment rather astonishingly resulted in vastly improved growth of maize and increased yields. The actual results of one experiment were:—

Control (no stover incorporated in soil): 2,170 lb. per acre shelled maize.
Maize stover dug in: 1,841 lb. per acre shelled maize.
Maize stover as a surface mulch: 1,855 lb. per acre shelled maize.
Matting: 2,569 lb. per acre shelled maize.

(A difference of 295 lb. per acre is significantly at 5 per cent).

This unexpected result did not seem to be due to any moisture conserving effect of the matting since the difference in growth was most marked in the early stages when ample rain fell sufficient to keep all plots uniformly moist and, indeed, the effect tended to wear off as the maize matured.

In a "Broadbalk" trial in which maize will be grown continuously under different manurial treatments a significant response was obtained this year (the second of the trial) to sulphate of ammonia and to farmyard manure. The sulphate of ammonia which is at a rate equivalent to the nitrogen content of the farmyard manure gave a higher, but not significantly greater, yield than the farmyard manure. Phosphate either by itself or in combination with nitrogen gave no response whatsoever. In a green manurial trial maize after green manure gave no increase as compared with maize after maize. It appears that in Tengeru soils the organic matter content of the soil is not a significant factor in crop yields.

In a series of spacing trials with maize it was shown that planting in double rows wide apart had no advantage (in as far as yields were concerned) compared with planting in single rows with the same total plant population. Equally there was no disadvantage and it may be convenient from the point of view of ease of cultivation to plant in double rows. At Tengeru (23″ rainfall during the growing period) closer spacing $3' \times 1'$ gave better results than wider spacing $3' \times 2'$ but at Oljoro (8″ of rain during the growing season) the results were reversed. Wide planting $4' \times 1'$ gave better results than close planting $2' \times 1'$. It was also shown that if maize is to be planted on virgin land which, as indicated above, may be of low fertility due to the "first year effect", it is advisable to adopt a wider spacing than normal.

An extensive series of field trials of different methods of establishing Rhodes Grass was also carried out at Tengeru and elsewhere involving under-sowing and under-planting in maize and also as treating the grass as a pure crop, with different methods of weeding including the use of hormone weed killers. It was found that the best method of establishing the grass was to treat it as a crop on its own and to drill it with a maize drill with the coulters removed and a light brush or chain harrow attached behind. This method used less than 5 lb. per acre of seed as against a minimum of 20 lb. if the seed was broadcast and enabled inter-row mechanical cultivation to be carried out during the early stages of growth when the Rhodes Grass is very susceptible to weed competition. Hormone weed killers were not very successful because of the heavy graminaceous weed flora.

L. J. S. Littlejohn,
Chief Soil Conservation Officer

REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), SOUTHERN HIGHLANDS PROVINCE, FOR THE YEAR 1954

1. INTRODUCTION

Work during 1954 has revealed that the behaviour of wheat varieties in the various trials conducted, has, on the whole, supported previous year's findings. As a general rule short-term wheats do best below 6,300 ft., whilst the longer-term varieties are better suited to the wetter mountainous areas. Yields were generally lower this season due to low rainfall in most areas.

Maize yields of the selected varieties used at Igumbiro Experimental Farm and on external trials have been encouraging. Eckstein is undoubtedly suited to the Iringa area and after three year's selection is now yielding an average of 9½ bags per acre. It is unfortunate that, being a yellow maize, the local demand for it is limited. Kenya White is successfully grown in the higher altitude areas, and a variety trial in which it was compared with eight Rhodesian Hybrid Varieties indicated that such imported hybrids would be unlikely to yield better. In Iringa District maize should be sown as early in the rainy season as possible, and at least two seeds should be sown in each planting hole. Enyanza Sorghum has been grown successfully at Iringa and this year yielded an average of 19 cwt. per acre. This crop might prove very popular in the area if a dwarf white variety could be found that yielded as well. Rainfall requirements are less than those of maize, and experiments have shown that plantings up to mid-January produce the highest yields, while the optimum plant density lies between 40,000 and 50,000 plants per acre grown in rows 2 or 3 ft. apart.

Of the Green Manure Crops grown at Igumbiro Farm, Velvet Bean and the two Crotalaria species did extremely well and would probably satisfy any demand in the Iringa District.

Several varieties of Sweet Cassava which are being grown and tested at Iringa are producing impressive results and are likely to prove far superior to locally grown types.

A.—Wheat

The experimental work onw heat was reduced thisseas on, only five variety trials being conducted in the Province; three of them in Mbeya District and two in Iringa District. In spite of a season of abnormally low rainfall three of these trials produced useful results. Two fertilizer trials and one cultivation experiment were also carried out.

1. *Wheat Variety Trials.*— In Iringa District the *Sao Hill Trial* at 6,000 ft. was successful and gave confirmation of the suitability of 291J1I1, 294B2A3, Kenya Settler and 261S10C2D for this area. 44/W/34, which had previously done well here, failed inexplicably this season.

The trial was sown at 90 lb. per acre on 5th February with a total application of 325 lb. of artificial fertilizers.

SOA HILL VARIETY TRIAL: WHEAT YIELDS

Variety	Yield per acre lb.	
294B2A3	1,342·25	
44/W/1	1,240·50	
184P2A1F	1,223·25	
291J1I1	1,216·25	A Significant Difference at
261S10C2D	1,056·00	5 per cent is 343 lb.
Kenya Settler	1,013·75	
321BT1B1	996·00	
261R7C1B	950·00	
44/W/34	604·25	

The *Kasanga Variety Trial* suffered severely from drought and produced yields of only one third of previous years' trials. No differences between varieties were significant

In Mbeya District low rainfall again affected yields, especially in the case of the *Mbosi Variety Trial* where grain production was extremely poor. In spite of this however, some results were significant and supported previous years' findings.

MBOSI VARIETY TRIAL: WHEAT YIELDS

Variety	Yield per acre lb.	
261S10C2D	341	
44/W/34	319	
291J1I1	299·2	
294B2A3	275	A Significant Difference at
44/W/1	249·7	5 per cent is 123 lb.
261R7C1B	209	
Kenya Settler	187	
Reward	187	
350AD9C2	143	

The conclusions that can be drawn from this and previous years' trials at Mbosi are that although yields become very poor in a season of low rainfall 44/W/34, 291J1I1 and 294B2A3 still outyield the other varieties.

The *Variety Trial at Uyole* this year again produced the highest yields, although they were lower than last year's record-breaking crop of 29 cwt. per acre from 44/W/34. This variety again significantly outyielded all other varieties grown by producing 25½ cwt. per acre, proving conclusively that for high production this variety is undoubtedly the best wheat for the Uyole area.

No fertilizer or manure was applied to the trial, which was sown on 4th March at 100 lb. per acre. An unidentified disease is reported to have seriously affected plants growing on the sites of last year's paths between plots.

UYOLE VARIETY TRIAL: WHEAT YIELDS

Variety	Yield per acre lb.	
44/W/34	2,850·00	
294B2A3	2,187·50	
184P2A1F	2,012·50	
Kenya Settler	1,850·00	A Significant Difference at
291J1I1	1,775·00	5 per cent is 595·75 lb.
261R7C1B	1,700·00	
261S10C2D	1,550·00	
44/W/1	1,537·50	
321BT1B1	1,512·00	

The *Njiapanda Variety Trial* at 7,300 ft. yielded fairly well, but no differences between varieties were significant. By comparing this season's "Order of Yield" with that of the previous years' it seems that 341F2D1 or 341F2D2 are to be recommended for this area; it cannot, however, be claimed that these varieties have been proved to be definitely better than others. The four varieties heading the list this year were:—

341F2D1 yielding 2,375 lb. per acre
Regent 975·6 yielding 2,200 lb. per acre
291J1I1 yielding 2,125 lb. per acre
341F2D2 yielding 2,087 lb. per acre

2. *Wheat Fertilizer Trials.*—Two wheat fertilizer trials were laid down this season, one at the Mbosi Coffee Sub-Station, and the other at Irambo, both being in Mbeya District. The results of the Irambo trial were not available when this report was compiled.

The *Fertilizer Trial at Mbosi* was planted on 9th and 10th March and suffered very severely from drought. Yields were very low and no definite conclusions could be reached on analysis of the results.

3. *Wheat Cultivation Trial.*—261S10C2D was used in an experiment planted at Sao Hill on 3rd and 4th February to study the effects of rolling and harrowing after planting on the yield and tillering of wheat. These treatments were applied on 16th March when the plants were about 4 inches high. Three different seed rates were included in the experiment which was of a randomized block design. A standard dressing of 150 lb. per acre of Dutch Mixture was applied to all plots.

Growth of the wheat was good throughout the season and the plots were harvested during June giving the following mean figures:—

WHEAT CULTIVATION TRIAL: YIELD AND TILLERING

Treatment	Tillers per plant		Yield per acre	
	(mean)		lb.	
Control	2·34		1,059·50	
Rolled	2·45	Nothing Significant.	904·67	Nothing Significant.
Harrowed	1·94		1,061·00	
Rolled and Harrowed	2·17		877·75	
Seed Rate 30 lb./acre	2·64	Significant Difference	942·88	
Seed Rate 70 lb./acre	2·24	at 5% 0·38	1,006·19	Nothing Significant.
Seed Rate 110 lb./acre	1·72	at 1% 0·52	971·38	

It can be concluded that after-cultivations, as applied in this experiment, have no effect on either tillering or yield. The only differences that were significant were between the tillering of plants at different seed rates, but even this did not significantly affect the ultimate yield.

The fact that in this experiment yield was not affected by seed rate should be regarded with a degree of caution. To rely upon a seed rate of 30 lb. per acre in practice would probably be unwise, as factors such as disease, bird damage ro poor germination, which did not apply in this trial might well take a toll on other occasions.

B.—Maize

1. *Mbosi Maize Experiments.*—Two fertilizer trials, a variety trial and a green manure trial were conducted in the Mbosi area this year.

(I) The *Clarke Maize Fertilizer Trial* was laid down to discover the effects of N, P, K, Lime and Dung on Mr. Clarke's Farm using a 3 × 2 × 2 × 2 design partially confounded. Planted on 7th December germination and growth were good, but although yields were high no differences between treatments were significant; this is attributed to the high inherent fertility of the soil.

EFFECTS OF NITROGEN PHOSPHATE POTASH, LIME AND DUNG ON MAIZE YIELDS IN THE CLARKE MAIZE FERTILIZER TRIAL

Treatment	Yield per acre lb.	
N. at 0	4,421	
N. at 21 lb. per acre	4,483	
P_2O_5 at 0	4,449	
P_2O_5 at 60 lb. per acre	4,456	
Lime at 0	4,453	Nothing Significant.
Lime at 1,120 lb. per acre	4,452	
K_2O at 0	4,409	
K_2O at 36 lb. per acre	4,392	
Dung at 5 tons per acre	4,556	

(II) The *Mbosi Maize Fertilizer Trial*, carried out on the Mbosi Coffee Sub-Station was laid out to a 3 × 3 × 3 partially confounded factorial design also to test the effects of applications of N, P, K and Dung. Results in this case were much more positive.

Throughout the growth of the plants the effects of Dung and Phosphate were clearly evident and the yield data at harvest showed a significant increase where Nitrogen, Phosphate and Dung were applied.

MAIN EFFECTS IN THE MBOSI MAIZE FERTILIZER TRIAL

Treatments	Yield per acre lb.	
Nitrogen at 0 lb. per acre	1,940	
Nitrogen at 21 lb. per acre	2,510	
Nitrogen at 48 lb. per acre	2,607	
P_2O_5 at 0 lb. per acre	1,646	A Significant Diff. at
P_2O_5 at 40 lb. per acre	2,598	5 per cent is 312 lb.
P_2O_5 at 80 lb. per acre	2,813	1 per cent is 424 lb.
K_2O_0 at 0 lb. per acre	2,044	
K_2O_0 at 48 lb. per acre	2,255	
Dung at 5 tons per acre	2,758	

This trial was conducted on a soil of lower fertility than the Clarke Trial.

(III) The *Maize Variety Trial* at Mbosi was also situated on the Coffee Sub-Station with the object of comparing the locally grown Kenya White Variety with eight Rhodesian Hybrids. A randomized block design of five replications was used and the maize was planted on 11th and 12th December.

No fertilizer was applied and growth in all cases was poor. The yield of individual varieties varied widely from plot to plot giving a high standard error, and consequently no significant differences were found.

It does not appear that it is worth while importing hybrid maize at high cost to the Mbosi area where it seems probable that good Kenya White seed yields just as well.

(IV) *Mbosi Green Manure Trial.*—This experiment was laid down this year to discover the effects of green manure on a succeeding maize crop, due to be planted in the coming season.

Velvet Bean was planted on 11th December, 1953 and ploughed in early in March after making good growth.

The effect of phosphate applications is included in the trial.

2. *Igumbiro Maize Experiments* (*Iringa*)—(I) Three Maize Planting Experiments were carried out at Igumbiro with the main objects of finding out optimum seed rate, spacing and time of planting.

The *Maize Rate of Seeding Trial* employed a randomized block design with split plots and was planted on 5th January with Eckstein seed. The aim of the experiment was to discover how many seeds should be sown in each planting hole, and the best method of applying a compound fertilizer.

Early in the growth of the plants cutworms destroyed many seedlings, but a reasonably good stand resulted in which the different seed rates could easily be distinguished by the regularity of the plants. When harvested the following yields were obtained:—

EFFECT ON YIELD OF NO. OF MAIZE SEEDS PER PLANTING HOLE

Seeds per Hole	Yield per acre lb.	
1. ...	2,050	A Significant Difference
2. ...	2,916	at 5 per cent is 585 lb. per acre
3. ...	3,200	at 1 per cent is 842 lb. per acre
4. ...	3,381	

It can be concluded that more than one seed per hole should definitely be sown, but that there is probably no advantage in using more than two. It should however be noted that where more than one plant grew from the same hole no thinning was carried out.

The results given by the compound fertilizer applications were not significant and were probably confused due to residual fertilizer remaining in the soil from the previous season's crop.

The *Maize Spacing Trial* was conducted to compare seven different spacing of maize arranged in five randomized blocks. The experiment was planted between 6th and 9th January and germinated well; cutworm damage, however, was again severe and some replantings had to be carried out. Harvesting took place at the end of July when the following yields were obtained:—

EFFECT OF SPACING ON MAIZE YIELD

Spacing	Plants/acre	Yield per acre lb.	
36 × 15″	19,200	2,066	
36 × 12″	24,000	2,042	
36 × 18″	16,000	2,039	
48 × 9″	24,000	1,969	Nothing Significant.
48 × 15″	14,400	1,954	
48 × 12″	18,000	1,773	
72 × 6″	24,000	1,660	

For the *Maize Time of Planting Trial* a similar design was used to accommodate the eight planting dates spaced at weekly intervals from 23rd December to 10th February. A standard dressing of Dutch mixture was applied in each case at planting.

Early growth in most cases was good, but the maize planted on 30th December was partially destroyed by birds. Harvesting took place in June and July.

YIELD OF MAIZE PLANTED ON EIGHT DIFFERENT DATES

Date of Planting	Rainfall (planting to harvest)	Yield per acre lb.	
December 23rd	13·61	3,094	
December 30th	12·67	1,315	(Damaged by birds)
January 6th	11·89	1,742	
January 13th	9·00	2,025	
January 20th	7·21	1,327	Significant Difference
January 27th	7·21	1,150	at 5 per cent is 394 lb.
February 3rd	5·81	986	at 1 per cent is 530 lb.
February 10th	5·35	1,049	

The maize planted on the earliest date significantly outyielded all later plantings (P 1%); also the plots planted on 13th January outyielded subsequent plantings. Indications are therefore that Eckstein should be planted early in the rainy season for maximum yields, but it will still produce a reasonably good yield with as little as 7 or 8 inches of rainfall during its growing period, provided this is evenly distributed.

Summary of Maize Experiments

(1) At Mbosi applications of Sulphate of Ammonia, Super-Phosphate and Dung were all found to increase yields of Kenya White considerably. A comparison between Rhodesian hybrid varieties and Kenya White indicated that the hybrids yielded no better than the locally grown variety. A Green Manure trial was started and the crop ploughed in. Maize will be grown in 1955 to test effects.

(2) At Igumbiro Experimental Farm (Iringa), Planting trials have shown that Eckstein should be sown early in the rainy season and that at least 2 seeds should be planted in each hole. The results of a spacing trial proved inconclusive. Green Manure and Rotation trials have been started at Igumbiro, results will be reported upon in due course.

C.—Sorghum

Three Sorghum experiments were undertaken at Igumbiro to investigate fertilizer requirements, spacing and time of planting. Enyanza sorghum was used in each case.

(1) The *Sorghum Fertilizer Trial* produced no significant results although stands were good and yields fairly high. Planted on 22nd January and harvested on 16th July the following mean yields were obtained:—

EFFECT OF FERTILIZER APPLICATIONS ON SORGHUM YIELD

Treatments	Yield per acre lb.	
Nitrogen at 0 lb. per acre	1,872	
Nitrogen at 5 lb. per acre	1,887	
$P_2 0_5$ at 0 lb. per acre	1,767	
$P_2 0_5$ at 20 lb. per acre	1,992	Nothing Significant.
$K_2 0$ at 0 lb. per acre	1,938	
$K_2 0$ at 15 lb. per acre	1,821	

The land on which the trial was conducted was of good fertility, and it is also possible that the crop may have obtained benefit from residual fertilizer used on previous tobacco crops.

(2) The *Sorghum Spacing Trial* compared six different spacings arranged in five randomized blocks. Planted without any application of fertilizer on 20th January, the trial grew well and was harvested on 16th July.

EFFECT OF SPACING ON SORGHUM YIELD

Spacing	Plants per acre	Yield per acre lb.	
24 × 6″	43,200	2,902	
36 × 3″	57,600	2,875	
36 × 6″	28,800	2,522	A Significant Difference
25 × 12″	16,200	2,260	at 5 per cent is 471 lb.
24 × 18″	14,400	2,085	at 1 per cent is 642 lb.
24 × 24″	10,800	1,880	

It can be concluded that the spacings of 24″ × 6″ and 36″ × 3″ are better than any of the others used, and that optimum plant density probably lies between 40,000 and 50,000 plants per acre.

(3) The *Sorghum Time of Planting Trial.*—At weekly intervals from 8th January to 5th February, Enyanza Sorghum was planted with a 100 lb. per acre dressing of Dutch Mixture. A 5 × 5 Latin Square design was employed.

YIELD OF SORGHUM FROM FIVE PLANTING DATES

Date of planting	Rainfall (Planting to Harvest) ins.	Yield per acre lb.	
January 8th	11·94	2,787	
January 15th	10·17	1,527	Significant Difference
January 22nd	9·35	3,047	at 5 per cent is 314 lb.
January 28th	9·08	2,222	at 1 per cent is 432 lb.
February 5th	7·95	1,810	

Good crop stands were obtained in all cases except for the 15th January planting, which appeared to have been adversely affected by the heavy rains and overcast conditions in its first week of growth. Plantings on 8th and 22nd January have done significantly better than any of the others. Sorghum appears to need planting in the second or third week of January, or when it is likely to receive at least 9 inches of rain.

(4) *Observation Trials. A. Grass Leys*

Seven grass ley observation trials were attempted at Uwemba in Njombe District, using seeds mixtures of Cocksfoot, Rhodes Grass, Crimson Clover and New Zealand Wild White Clover.

Germination in all cases was extremely variable, but on most sites a reasonable sward was eventually produced. It seems that establishment is more difficult to obtain on the Ash soils than on the Red Granitic type. The relative merits of Rhodes Grass and Cocksfoot at Uwemba seem to be rather obscure; both did reasonably well on some sites but failed on others for no apparent reason. Rhodes Grass tends to flower earlier than Cocksfoot and to produce a better initial growth, after flowering however, it dries out rapidly while Cocksfoot struggles on remaining green without flowering.

Crimson Clover was in most cases disappointing, and although Wild White Clover made quite good growth early in the season, it succumbed quickly after the rains ceased; it is very doubtful whether it will recover when the rains start again.

It is felt on the whole that Rhodes Grass offers the most hopeful line of advance for grass leys in the Uwemba area, and a high altitude type from Kenya is to be tried on a small scale in the coming season. This year's trials cannot be said to have indicated any obviously suitable ley practice, but it is believed that this may be partly due to a rather over-ambitious programme.

The problem of finding a satisfactory legume for inclusion in ley mixtures remains unsolved.

At Igumbiro Experimental Farm a small plot of Rhodes Grass was planted at the end of the rains with no manurial dressing. Somewhat surprisingly this established itself strongly and has, after resting from grazing, overcome weed competition. Although it dried out later in the dry season, it is hoped that when the rains begin it may produce a very useful sward.

B. Forage Legumes and Green Manures

1. *Cowpea (Potch.).*—This was planted in the second week of February. It received a total of 7·69 inches of rain and grew quickly to maturation in an average of 94 days. The weight of green material produced per plant was not great and for a thick coverage a close spacing is recommended. The plants were upright in habit, about 2 ft. high, producing long narrow pods containing small brown seeds. Yield of seed was 889 lb. per acre.

2. *Crotalaria Species.*—Plots of both *C. juncea* (Sunn Hemp) and *C. spectabilis* were planted on 19th January and harvested for seed between the middle of May and the end of July. They received a total of 9·35 inches of rain during growth.

C. juncea produced excellent growth and coverage, attaining a height of over 5 ft. Establishment and germination were both quick and good.

C. spectabilis also produced good growth and coverage and particularly impressed tobacco growers due to its lower growth than Sunn Hemp and less tendency to become woody; it is consequently more easily ploughed in. Germination and early establishment were however, considerably poorer than that of Sunn Hemp.

COMPARATIVE SEED YIELD AND MATURATION PERIOD OF CROTALARIA JUNCEA AND SPECTABILIS

	Yield per acre lb.	Maturation period days
C. juncea ...	502·73	106–191
C. spectabilis ...	1,199·33	107–161

3. *Lupins.*—The following varieties were planted:—Yellow Sweet, Yellow Sweet (S.A.O.), Bitter White and Blue.

All except the Bitter White failed again this season, producing only a sparse coverage of stunted plants which died out soon after the rains ceased. All were planted during February and the seed was inoculated with the correct Rhizobium bacteria.

The Bitter White variety however, germinated well and although termites took a toll on the young plants, the remainder began flowering by the end of March and produced seed in an average of 123 days. The spacing used was 2′ × 15″ and it is felt that for good coverage a higher plant density should be used.

4. *Desmodium Distortum.*—Planted on the 4th February, 1953, early growth was slow and disappointing. As it developed however, the Desmodium gradually smothered weed competition and covered the ground well, standing green throughout the 1953 dry season. In December, 1953 the plants flowered and set seed. During 1954 it has stood about 5½ft. high and has become very woody near the base. In December, 1954 the plants were cut right back, almost to ground level, and any new growth during the coming season's rains will be observed with interest.

In February 1954 a few seeds of this species were scattered on a grass ley at Igumbiro; these germinated and produced strong low plants which were kept heavily grazed by cattle, but which remained green long into the dry season. In the last few months the plants have lost their green foliage, but with the coming of the rains it is hoped that they will revive and once more produce good grazing.

5. *Kudzu.*—An attempt was made to grow this crop from seed this season, but early growth was very poor and, soon after the rains ceased, the plants died.

6. *Velvet Beans.*—Six varieties were planted on 19th January at Igumbiro Farm. Whilst all varieties germinated and grew well, the most promising was J 52; this produced a perfectly even cover about 18 inches deep. Variety Somerset was the quickest to establish ground cover; the remaining varieties were slower growing, and only produced a good coverage in patches.

Local Black was the slowest maturing but continued to produce new green foliage long after the other varieties had died.

VELVET BEAN—GROWTH PERIOD AND SEED YIELD OF SIX VARIETIES

Variety	Maturation Weeks	Yield per acre lb
J. 52	28	1,799
Somerset	25	1,618
J. 54	27½	1,430
J. 77	28	1,217
Local White	27½	1,054
Local Black	30	757

C. Root Crops

1. *Cassava Observation Trials.*—Early in 1952, fifteen new varieties of Cassava were introduced to Igumbiro Experimental Farm and were harvested about two years later, early in 1954. The findings of that trial were the subject of a report submitted in February 1954. Twelve of these varieties grew successfully all having high palatability and yielding an average of over 3 lb. per plant; all are of the "Sweet" type. A List of the four highest yielding varieties is given below.

Ankrah	yielded an average of	7·43 lb.	per plant
Msitu	„ „	6·22 lb.	per plant
3744/E	„ „	5·37 lb.	per plant
Binti-Minisi	„ „	5·25 lb.	per plant

It was decided that three of the original varieties should be discarded, and the remaining twelve were planted again in January, 1954 for further investigation and distribution in the Province.

These plots have established themselves well and all have remained green and healthy to the end of the dry season. In the coming season a replicated variety trial is to be conducted.

2. *Sweet Potatoes.*—A plot of Caroline Lee potatoes is being grown at Igumbiro and will be propagated in order to increase stocks of planting material next season. The few plants remaining from last season's crop have survived the dry season and are beginning to make new growth.

(5) *Food Crops at Igumbiro Experimental Farm. A. Legumes*

1. *Local Beans* were planted on 25th January and grew very well. Flowering started in late February and the crop was harvested in mid-April. From Planting to harvest the crop received 9·35 inches of rain in 28 days.

Yield; 209·35 lb. per acre. Maturation; 77-96 days.

2. *Groundnuts.* Valencia and Mgogo varieties were planted on 1st and 2nd January. A top dressing of Sulphate of Ammonia was applied in late January and flowering began in early March. Growth and yield of Mgogo was poor, whilst that of Valencia was reasonably good.

Valencia; Yield 337·68 lb./acre; Maturation in 140-178 days
Mgogo; „ 127·73 „ „ ; „ „ 172-178 „

3. *Haricot Beans* were planted on 23rd January and on 19th February, but all were severely attacked by Halo blight early in March. Yield: 182·97 lb. per acre. Maturation in 68-100 days.

4. *Soya Beans* were planted on 18th January. Growth was excellent and flowering began early in March. Pods were well formed by mid-April and the Crop yielded 634·19 lb. per acre in 14-18 weeks.

B. Cereals.

1. *Eckstein Maize* was planted with 200 lb. per acre of Dutch Mixture in the latter part of December. Sulphate of Ammonia was applied as a top dressing in mid-January. Maturation took $6\frac{1}{2}$ months and the average yield was 9 bags per acre.

2. *Katumbile Maize* was cultivated under similar conditions with the same treatments and yielded $4\frac{1}{4}$ bags per acre in $6\frac{1}{2}$ months.

3. *Enyanza Sorghum* was planted during January and after a poor start and some reseeding, due to bad germination, the crop grew well yielding 2,022 lb. per acre in July.

PYRETHRUM EXPERIMENTS, 1954

INTRODUCTION

The Pyrethrum Experimental Work run by the Uwemba Farmers' Association has, over the past five years, produced a wealth of information on pyrethrum cultivation in the Southern Highlands. Some of the knowledge gained has been of a negative nature, but this is only to be expected in any type of research work; it is often almost as important to know of methods which would prove of no value if applied in the field, as it is to learn of a practice which will produce a dramatic improvement. Such improvements are rare, but their discovery depends to a great extent on the accumulation of facts and indications, even if these are negative and may seem individually unimportant at the time.

The Uwemba experiments are building up such a background of knowledge, and in addition have led to the discovery of several improved practices, some of which have already been adopted on the farms; these include points such as single row ridging, the stripping method of picking and six inch spacing, all of which have now become common practices on all farms.

Uwemba Farmers may feel justly proud of their experimental policy and of the results it has yielded in the past. The 1954 Season has now produced more results which point the way to higher yields, and the programme for the future includes a comprehensive study of the maintenance of fertility and increased production on all main soil types in the area.

A Summary of More Important Results from 1954 Experiments

The three original fertilizer trials have all shown conclusively that the application of 300 lb. per acre of Super-Phosphate is an economically sound proposition. It should be noted however that, in the case of soils containing volcanic ash, all experimental data so far points to the fact that the first 150 lb. applied is not available to the pyrethrum; Super-Phosphate should therefore be applied at more than 150 lb. per acre to volcanic ash soils.

From the Planting Date Trial it now appears that plantings made between December and March yield a similar weight of flowers over a three years period, and that there is no disadvantage in late planting up to mid-March unless a quick return in the first season is required. Planting in the middle of November however, yielded 550 lb. per acre more over three years than any other planting, date; a factor which indicates a potential advantage if irrigation were available to allow such early planting.

Mulching between alternate rows of pyrethrum has increased yields by more than 100 lb. per acre per annum; this practice is to be thoroughly investigated in 1955.

Two trials have been carried out in anticipation of the introduction of mechanized cultivations. In the first instance it has been shown that the cutting of pyrethrum roots at 3" at trans-planting has no ill effect on later growth and yield; secondly harvesting with a type of picker designed by Col. Notcutt was found to result in no yield reduction.

In one experiment an ounce of water, when applied to the transplanting hole, was found to increase the first year's yield by 58 per cent. Although the conditions of the trial were not altogether satisfactory the matter is to be further investigated in the coming season.

Weather

This season has again been poor and for the second year in succession most growers have suffered low yields. Rainfall in the first half of the year was about 10″ below average, which may have accounted for the very poor second flush in October.

On some farms weed growth was exceptionally vigorous, causing considerable loss of yield.

Report on Experiments Completed in 1954

A.—Fertilizer Trials. Final Season's results.

Experiment No. 1—TREATMENTS AND MEAN TREATMENT YIELDS

Treatment	Yield (lb. dry flowers per acre)		
	1950-53	1954	Total
	lb.	lb.	lb.
No Super-Phosphate	3,604·7	403·2	4,007·9
150 lb. Super-Phosphate per acre	3,631·2	385·6	4,016·8
300 lb. Super-Phosphate per acre	4,096·6	427·1	4,523·7
No Lime	3,862·7	398·6	4,261·3
2 tons Lime per acre	3,683·1	405·1	4,088·2
4 tons Lime per acre	3,791·9	412·1	4,204·0
6″ Spacing between plants	3,686·9	428·1	4,115·0
9″ Spacing between plants	3,696·6	394·6	4,091·2
12″ Spacing between plants	3,949·0	393·1	4,342·1

Standard Error 15·06 per cent.

None of the differences between treatment yields was significant in 1954. The total yield over 5 years due to 300 lb. Super-Phosphate significantly out yielded other levels of this fertilizer at the 5per cent point.

Experiment No. 2—TREATMENTS AND MEAN TREATMENT YIELDS

Treatment	Yield (lb. of dried flowers per acre)		
	1950-53	1954	Total
	lb.	lb.	lb.
No Super-Phosphate	1,368·3	150·0	1,518·3
150 lb. Super-Phosphate per acre	1,696·5	153·4	1,849·9
300 lb. Super-Phosphate per acre	1,808·8	163·4	1,972·2
No Lime	1,596·1	160·1	1,756·2
2 tons Lime per acre	1,589·5	150·2	1,739·7
4 tons Lime per acre	1,685·0	156·4	1,841·4
No Ammonium Sulphate	1,514·8	137·4	1,652·2
100 lb. Ammonium Sulphate per acre	1,609·4	147·3	1,756·7
200 lb. Ammonium Sulphate per acre	1,749·5	179·4	1,928·9

Standard Error 43·4 per cent.

No Treatment Difference was Significant in 1954. The total yield over 5 years of both levels of Super-Phosphate were significantly higher than where the fertilizer was not applied.

Experiment No. 3—TREATMENTS AND MEAN TREATMENT YIELDS

Treatment	Yield (lb. of dry flowers per acre)		
	1951-53	1954	Total
	lb.	lb.	lb.
No Super-Phosphate	1,213·1	203·8	1,416·9
150 lb. per acre Super-Phosphate	1,259·0	186·1	1,445·1
300 lb. per acre Super-Phosphate	1,380·6	169·5	1·550·1
No Compost	1,308·5	181·4	1,489·9
5 tons Compost per acre	1,268·7	194·4	1,463·1
10 tons Compost per acre	1,285·4	183·2	1,468·6
12" between plants	1,291·8	188·1	1,479·9
9" between plants	1,226·7	166·4	1,393·1
6" between plants	1,344·2	205·0	1,549·2

Standard Error 24·1 per cent

No treatment differences were significant this season.

General Comments on Experiments Nos. 1, 2 and 3

The results of these three trials are in themselves a strong recommendation to Uwemba farmers to apply Super-Phosphate to the land when they plant pyrethrum. The indications are that both on soils containing volcanic ash and on those that do not, a larger profit per acre will result.

The cost of 300 lb. of Super-Phosphate (40 per cent P_2O_5) is Shs. 114/- at Uwemba, and the cost of application is not great as it is best administered at the same time as transplanting. From such an application a farmer could reasonably expect to more than cover his costs in the first season's harvest, and to obtain an increased yield of at least 250 lb. per acre of dry flowers over the first four years; this figure takes into consideration the difference between experimental yield levels and those obtained in the field.

It would however be unwise at this stage to recommend levels of application of less than 300 lb. per acre as, on the ash soils especially, it seems likely that the soil may "Lock up" at least 150 lb. in an unavailable form.

Regarding the decline in yield of pyrethrum after the second harvest season, it is worth noting that in the ash soil and forest soil trials a fairly high yield was maintained through to the fifth harvest, although a decline did occur each year. On the sandy soil however, there was a very marked drop in yield in the third, season (1952), and by experimental standards yields were very low thereafter.

In 1953 and 1954 all yields were probably lower than would normally have been the case had those seasons been normally favourable.

B.—Planting Trials

Four trials associated with various aspects of transplanting were completed this season.

Experiment No. 24. Planting Date Trial.—(3rd Season). It has been generally held that early planting in December or January leads to better yields; a belief that has been based on a previous experiment (Uwemba Pyrethrum Experiment No. 9; see 1953 Pyrethrum Report), as well as on farmers, experience.

There is also a school of thought which believes that pyrethrum "makes up for lost time" later in its life, and that if planted late, will eventually produce correspondingly higher yields to compensate for its bad start.

Experiment No. 9 ran for only two years. In the first season the earliest plantings (January) outyielded the later ones, and in the second season there were no significant differences.

The present trial was conducted to investigate the subject in more detail, especially with regard to plantings earlier than January. It was carried out by Commander Dathan on a deep volcanic ash soil, and in three years growth has produced the following yields:—

Experiment No. 24—PLANTING DATES: MEAN TREATMENT YIELDS OVER THREE SEASONS

(LB. OF DRY FLOWERS PER ACRE)

Planting Dates	1952	1953	1954	Total
15th November, 1951	970·7	882·0	584·0	2,436·7
15th December, 1951	685·0	715·7	481·4	1,882·1
15th January, 1952	564·5	627·9	403·6	1,596·0
15th February, 1952	359·1	820·4	686·4	1,865·9
15th March, 1952	252·9	715·6	603·8	1,572·3
Significant Difference at 5 per cent	219·8	N.S.	125·5	545·0

Standard Error in 1954, 14·8 per cent. Over three years, 18·7 per cent.

In the first season the November plantings significantly outyielded all later ones, and December and January plantings outyielded March (all at the 5 per cent point of significance).

There was no significance in 1953.

In 1954 February plantings outyielded December and January (at the 1 per cent point).

In the total yields for the three years November outyielded all other planting dates at the 5 per cent point, but there was no significant difference between the total yields of any other plantings.

CONCLUSIONS

The analysis of these results indicates that for most practical purposes if pyrethrum is planted as late as February or mid-March it does make good the first season's low yields in the following years; in fact over the total yields from the three years there is no difference attributable to planting date.

The only exception to this, and it is a very marked one, is that the November plantings maintained their original lead over the remainder, and at the end of the three years were more than 550 lb. per acre ahead of any of them. Since however, there is only very rarely sufficient rain in November for planting to begin, this result must be set aside; it does however indicate a potential advantage in irrigating pyrethrum and thus making such early planting possible; a practice which is probably to be tried at Uwemba.

If the farmer's object is to obtain as high a yield as possible in the first season he should plant as early as possible, for all experimental work has shown conclusively that later planting reduces yields in the first season. If however planting is delayed until February or even March, the results of this trial show that the total yield obtained over the life of the crop may be no less than an earlier planting would have produced.

It is worth noting that the results of this experiment do not conflict with those of Experiment No. 9; in fact results in the first two years of both trials are remarkably similar. It was only in the third season that late plantings significantly outyielded some of the earlier ones.

Experiment No. 41. Root Cutting Trial.—(2nd Season). Conducted on Commander Dathan's farm on a deep volcanic ash soil, this trial has given useful information in connection with the mechanization of transplanting.

The Objects were (a) to discover whether cutting the roots of splits to 3″ had any ill effects on subsequent yield, and (b) to obtain data concerning the utilization of Super-Phosphate and Sulphate of Ammonia by such cut splits.

Laid out as a 4 × 4 Latin Square and planted in February, 1953, the results of both years' harvesting showed no effects due to root cutting.

In the first year the treatment which included 50 lb. of Super-Phosphate placed in the planting hole produced a significantly higher yield than where all the fertilizer was placed under the ridge; no residual difference was detectable however in 1954.

Experiment No. 41—MEAN TREATMENT YIELDS IN LB. OF DRY FLOWERS PER ACRE

Treatment	1953	1954	Total
A. Roots 8″; 150 lb. Super under ridge	291·6	642·9	1,281·9
B. Roots 3″; 150 lb. Super under ridge	269·1	672·8	941·9
C. Roots 100 lb. Super under ridge ... ... 50 lb. Super in planting hole	358·3	719·1	1,077·4
D. Roots Same as "C" plus 100 lb. Sulphate of Ammonia in planting hole	357·4	688·1	1,045·5

Standard Error in 1954, 27·3 per cent

Conclusions

If, in any mechanical transplanter that may be introduced, short-rooted splits have to be used, yield will probably not suffer on this account.

The result from the Super-Phosphate applications indicates that at least some of the fertilizer is probably best placed in the planting hole, but the matter should be subjected to further study as this trial only touches on a part of the question. The matter of Phosphate placement has been the subject of some controversy in Uwemba, but in the opinion of the writer a reliable answer cannot be based on this trial alone or on Experiment No. 45, a placement trial which was run in 1953 without control treatments.

Sulphate of Ammonia applied in the presence of Phosphate did not affect yield in this trial.

Report on Current Trials

Experiment No. 14; Rotation Trial.—This experiment was started in January (4th season), 1951 and is being conducted by Commander Dathan.

Four randomized blocks are sited on a sandy forest soil overlying a red sandy loam.

The object is to study the effects of rotations which include peas, cereals and weeds between crops of pyrethrum, with a view to discovering a suitable cropping plan which will maintain soil fertility and pyrethrum yields.

It will not be possible to learn anything from this trial until the end of the 1955 season, as the rotation effects will not be properly felt until then; but from 1955 onwards results should become increasingly reliable.

Experiments 37 and 38; Seed versus Flowers.—(3rd season of pyrethrum; 2nd year of trial). The object of these two trials, which are identical in treatments and design, is to find out the best time of year to take seed from pyrethrum, and to study the effects of seed production on subsequent flower yield.

Experiment No. 37 which is being conducted by Commander Dathan on volcanic ash soil, has given the following results over the first two years. (A randomized block design of four replications is employed.)

Experiment No. 37—MEAN TREATMENT YIELDS 1953-54
(DRY WEIGHT IN LB. PER ACRE)

Treatments	1953		1954		TOTAL	
	Flowers	Seed	Flowers	Seed	Flowers	Seed
A. Picked for flowers only	941·7	—	624·7	—	1,566·4	—
B. Seed in first year, flowers in second year ...	—	246·2	571·8	—	571·8	246·2
C. Picked for seed only	—	261·4	—	228·6	—	490·0
D. Seed in first flush; flowers after	527·4	37·1	323·3	36·4	850·7	73·5
E. Flowers until second flush; seed after ...	445·8	235·0	308·7	94·4	754·5	329·4
F. Seed in both flushes; flowers between ...	122·4	244·5	131·2	154·2	253·6	398·7

Experiment No. 38 is being carried out by Mr. Davidson on a sandy forest soil and has given these results:—

Experiment No. 38.—MEAN TREATMENT YIELDS 1953-54
(DRY WEIGHT IN LB. PER ACRE)

Treatments	1953		1954		TOTAL	
	Flowers	Seed	Flowers	Seed	Flowers	Seed
A. Picked for flowers only	628·0	—	374·9	—	1,002·9	—
B. Seed in first year; flowers in second year ...	—	221·8	314·4	—	314·4	221·8
C. Picked for seed only	—	253·2	—	208·3	—	461·5
D. Seed in first flush; flowers afterwards ...	353·3	38·8	186·4	22·8	539·7	61·6
E. Flowers until second flush; seed afterwards	263·6	161·2	139·2	82·0	402·8	243·2
F. Seed in both flushes; flowers in between...	105·8	195·1	52·6	108·0	158·4	303·1

In 1955 the whole of both trials will be harvested for seed in order to judge after affects of seed production. The results cannot therefore be usefully analysed until then, and a full account of the experiments will be included in next year's report.

POINTS EMERGING FROM RESULTS OF THE FIRST TWO YEARS

1. It is clear from the results of both trials that the value of a seed crop greatly exceeds that of a flower crop to the extent of about Shs. 3,000/- per acre per annum, provided there is a market for the seed.

2. Both trials indicate that higher seed yields are obtained in the second flush than in the first, whereas flower production is good in both flushes.

3. By taking seed in both flushes and flowers at other times (Treatment F) the increase in seed yield over 2nd flush picking only does not seem to be marked, whereas flower production falls considerably.

4. In comparing the two trials an interesting trend emerges, in that whilst flower production is noticeably lower in the sandy soil trial, there is little difference between seed production of the two soil types. This seems to indicate that if a farmer wishes to grow seed he might just as well take it from his "poorer" soils and save the soils containing ash for flower production.

5. During the course of the trials tests were made to determine the time required for one boy to prepare one pound of seed. The results vary from 22·8 minutes to 163 minutes for trial 37, and from 34·4 to 172 minutes for trial 38.

6. Germination Tests were also carried out on the seed produced. For seed harvested in 1953 (October) and sown at intervals from January to October in 1954, a slight fall in viability occurred as the length of time between harvest and sowing increased. The figures obtained are given in the following table:—

Expts. 37 and 38—GERMINATION TESTS. PERCENTAGE GERMINATION OF SEED HARVESTED IN OCTOBER 1954 AND SOWN IN THE FOLLOWING YEAR

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct. 1954
Experiment 37	48·0	48·0	51·5	43·5	40·0	26·5	32·5	35·0	33·0	32·0
Experiment 38	37·5	40·5	51·0	41·5	38·0	28·0	20·0	27·5	38·0	39·0

Where freshly harvested seed was sown in the same month, germination counts were found to be very inconsistent, varying from 15 to 67 per cent without any definite trends being discernable.

All these tests were carried out under the initiative and supervision of Colonel Notcutt.

7. If the production of seed ever takes an important place in the farming system at Uwemba, an investigation into the apparent lack of correlation between seed and flower yields might well prove of value.

Experiment No. 63; Planting Technique Trial.—(1st Season). This experiment was laid down to a randomized block design on Colonel Notcutt's farm to ascertain whether care in planting might account for the marked differences between experimental and field yields that have occurred in the past.

Further treatments have been included in the trial to test the effect of applying small amounts of water in the planting hole.

The soil type is a sandy forest loam overlying a red sandy clay loam.

Experiment No. 63—MEAN TREATMENT YIELDS IN 1954 (1ST SEASON)
(LB. OF DRY FLOWERS PER ACRE)

Treatments	Yield
	lb.
A. (Careless Planting)	63·2
B. (Careful Planting)	84·1
C. (Careful Planting and 1 oz. of water)	127·4
D. (Careful Planting and 2 oz. of water)	90·1

A Significant difference at 5 per cent is 42 lb. per acre.
Standard Error 34·6 per cent.

Conclusions

From these results it appears that water applied to the planting hole has definitely increased the first season's yield.

There is no significant difference between careful and careless planting methods, but in view of the high standard error no definite conclusion can be drawn on this point.

Experiment No. 64. Mechanical Picking Trial.—(2nd Season of Pyrethrum; 1st year of Trial). Conducted by Colonel Notcutt, this is a second trial designed to discover whether a mechanical method is likely to affect yield.

In this case the yield from established pyrethrum picked by hand is compared with that obtained when a comb-type of picker is used.

Hand-harvesting produced a yield of 481·3 lb. of dry flowers per acre, and Mechanical Picking yielded 497·5 lb. per acre. There is no significant difference between the two, and since the Standard Error is fairly low (9·2 per cent) it can be concluded that yield remains unaffected by this method of picking.

Experiment No. 66; Further Investigation of Nitrate.—(1st Season). As the figures from earlier experiments have suggested that Sulphate of Ammonia applications may have increased yields over several seasons, but without ever attaining significance, it was decided that a further trial should be carried out.

This experiment was planted in January, 1954 and received a basic dressing 150 lb. per acre of Super-Phosphate (40% P_2O_5); it is being conducted by Mr. Davidson on a deep ash soil overlying a red sandy clay subsoil.

Experiment No. 66—MEAN TREATMENT YIELDS IN 1954.—(1st SEASON)
(lb. of Dry Flowers per Acre)

Treatments	Yield lb.
No Nitrogen	88·60
150 lb./acre Ammonium Sulphate	95·50
300 lb./acre Ammonium Sulphate	83·90

Standard Error 29·3 per cent.

Due to the poor season yields are low and have probably been limited by this factor; there is therefore no significant difference between treatments.

A further year's results are needed before any definite conclusions can be drawn.

Experiment No. 67; Rock Phosphate Trial.—(First Season). This Experiment is being conducted by Mr. Togni on a volcanic ash soil overlying red clay containing murram. It was planted during January, 1954 to a 5 × 5 Latin Square design to test the effects of Rock Phosphate with and without Super-Phosphate. Poor Rainfall and low yields have again prevented the demonstration of any significant effects, but it should be noted that the levels of Super-Phosphate applied are below the 150 lb. per acre level which failed to give a response in the earlier trials on an Ash Soil.

Experiment No. 67—ROCK PHOSPHATE TRIAL. MEAN TREATMENT YIELDS IN 1954 (1ST SEASON)

(LB OF DRY FLOWERS PER ACRE)

Treatments	Yield lb.
A. No fertilizer	88·17
B. 100 lb. Rock Phosphate per acre	121·98
C. 200 lb. Rock Phosphate per acre	105·28
D. 100 lb. Rock Phosphate; 50 lb. Super-Phosphate per acre	115·33
E. 100 lb. Rock Phosphate; 100 lb. Super-Phosphate per acre	112·77

Standard Error 25·44 per cent.

Experiment No. 68; Mulch Trial.—(2nd year pyrethrum; 1st year of Trial).

Laid down on pyrethrum that was planted in 1953 and already well established, this trial is being conducted by Mr. Davidson to determine the effects of mulching on pyrethrum yield.

The soil is a mixture of a sandy forest type with some transported ash, overlying a sandy clay subsoil.

In the mulch treatment long grass was laid between alternate rows of pyrethrum, filling the furrow; plots treated in this way yielded 513·7 lb. of dry flowers per acre whilst unmulched plots gave 406·4 lb. per acre. The Standard Error was 12·3 per cent and a significant difference at 5 per cent is 100 lb. per acre.

It is therefore reasonably certain that over the course of the year mulch has increased yield. It is also interesting to note that although at every picking the yield of mulched plots exceeded that of the unmulched, the greatest differences occurred in February, March and April, when the rains were still falling. As soon as the dry season began the difference started to decline.

While the trial was in progress soil moisture readings were taken by Colonel Notcutt; Some of these have been extracted from his very comprehensive series of figures, and included in the following table:—

Experiment No. 68—MULCH TRIAL; TABLE SHOWING INCREASE IN MOISTURE CONTENT OF SOIL AND PYRETHRUM YIELD DUE TO MULCH

Period	Application					
	Mulched Plots		Unmulched Plots		Increase Due to Mulching	
	Mean Soil Moisture	Yield	Mean Soil Moisture	Yield	Soil Moisture	Yield
	per cent	lb. per acre	per cent	lb. per acre	per cent	lb. per acre
1. Up to 25th February ...	—	76·5	—	59·5	—	17·0
2. 25th February to 22nd March	—	119·5	—	108·5	—	11·0
3. 22nd March to 22nd April...	—	49·0	—	37·5	—	11·5
4. 22nd April to 25th May ...	48·7	26·3	41·6	20·3	7·1	6·0
5. 25th May to 16th June ...	34·3	17·8	30·2	14·1	4·1	3·7
6. 16th June to 15th July ...	26·7	27·7	23·3	22·0	3·4	5·7
7. 15th July to 12th August ...	21·7	41·7	18·6	30·6	3·1	11·1
8. 12th August to 9th September	15·9	53·1	12·9	46·2	3·0	6·9
9. 9th September to 7th October	12·1	50·3	10·1	47·1	2·0	3·2
10. 7th October to 5th November	9·9	25·4	8·5	22·9	1·4	2·5
11. 5th November to 2nd December	—	9·6	—	7·7	—	1·9

NOTE: 1. Moisture readings were not started until May.

2. The yields of one block out of the six laid down were discarded in the statistical analysis as they were affected by neighbouring eucalyptus trees; they are however included in the above table).

A correlation between mulching and soil moisture content is apparent, and also between these two and yield increase.

The *Dabaga Pyrethrum Spacing × Super-Phosphate Trial.*—(1st Season).

This experiment was planted on 1st March, 1954 on Mrs. de Leyser's farm. It is the only pyrethrum trial this season which is being conducted outside the Uwemba area.

The object of the trial is to determine responses to Super-Phosphate applications and spacings in the Dabaga area, and for this purpose a 3 × 2 factorial design was employed with split plots for the three Phosphate levels.

The soil on which the experiment is sited is fine reddish sandy loam overlying a red clay subsoil.

Due partly to late planting and partly to the bad season yields in this first year have been very low. The experiment is remarkable however, in having an extremely low Standard Error, and consequently even the small difference between plots with and without phosphate is highly significant.

DABAGA PYRETHRUM SPACING × PHOSPHATE TRIAL;
MEAN TREATMENT YIELDS 1954

(lb of Dried Flowers per Acre)

Phosphate Treatments	Spacings		Mean
	6″	12″	
	lb.	lb.	lb.
No Phosphate	62·48	54·14	58·4
150 lb. Super-Phosphate per acre	78·45	76·85	77·7
300 lb. Super-Phosphate per acre ... ... (40 per cent $P_2 0_5$)	81·02	75·15	78·1
Mean	74·0	68·7	

Significant difference between Phosphate treatments at 5 per cent, 3·70 lb. per acre.

Standard Error, 1·37 per cent

It is an inherent weakness in any split plot design that differences between main plot treatments, (in this case the spacing treatments), must be well marked before they can become significant. It cannot therefore be assumed from these results that there is no difference in yield between 6″ and 12″ spacing; had the season been favourable and yields generally higher, the difference would probably have been significant, as it has been in other pyrethrum spacing trials.

The two phosphate applications produced yields significantly better than "No Phosphate" at the 0·1 per cent point.

Conclusions

In this season a dressing of Super-Phosphate at 150 lb. per acre has increased yields by approximately 20 lb. per acre. Although this fact alone is not of immediate economic importance it would be reasonable to suppose that, had conditions favoured a normal first year yield, the increase would have been much more marked. It is to be hoped that in the coming season the Super-Phosphate applications will show themselves to be of economic value.

Although not significant, it is probably true to say that first year yields are higher at Dabaga from plants spaced at 6″ than those spaced at 12″. Previous spacing trials indicate that it is doubtful whether yield differences due to this cause will be very marked in the second season, however this trial may prove exceptional in this respect if the very low standard error can be maintained.

ACKNOWLEDGMENTS

The Uwemba Farmers have taken into their own hands the responsibility for developing a successful farming system. To help in this development they are running a most ambitious and far-sighted programme of field experiments in which new ideas are constantly being tested. They believe that the Agricultural Department can help them in this connection, and an ideal example of co-operation between farmers and the Department has been built up. To Colonel L. A. Notcutt must go a great part of the credit for initiating and actively working for this policy.

The writer of this report wishes to express his sincere appreciation of the help he has received since his arrival in September, from all farmers concerned in the experimental work.

Much of the information in the report was supplied by Mr. R. Frank, the previous experimental officer, for whose advice and explanations in connection with this work the writer is most grateful.

J. R. Tuckett,
Agricultural Officer

COAST AGRICULTURAL STATION, CHAMBEZI, ANNUAL REPORT, 1954

Introduction

From 1951 to 1953 most of the work done on the station was concentrated on cleaning up the coconut plantations which had been allowed to become derelict before the Department took over the estates, and the construction of adequate farm buildings and accommodation for European and African Staff. With this work nearing completion it was possible during 1954 to proceed with fairly extensive new planting of coconuts and the commencement of more experimental work. Even so the Agricultural Officer found it difficult to devote as much time as he would have liked to field experimentation. By the end of the year, however, the organization of the station was working pretty smoothly and in future the Agricultural Officer should be able to devote a considerable amount of his time to experimental work, while the Field Officer supervises field operations and maintains the machinery.

Although experimental work on the station is mainly concerned with coconuts from which no results can be expected for a decade, a certain amount of work is done on other crops and such information as has already been obtained is summarized in this report.

Weather

Once again it was not a very satisfactory year climatically. The main rains started late and ended abruptly before the end of May with no "tailing off" showers. During May rainfall was excessive and some annual crops were drowned. Later the surviving crops suffered from drought when maturing. Although the records show that it was a year of high rainfall, crops were most disappointing and several experiments were spoilt.

The short rains were even more unsatisfactory although the records again show an excellent total rainfall. Falls of 3·65 inches in 24 hours and 6·96 inches in 18 hours on 11th and 23/24th October respectively, constituted the short rains. Rainfall of such intensity is practically useless except for established tree crops. Only negligible amounts of rain fell in November and December, and there will be no short rains crops to harvest.

Rainfall statistics for the year were:—

Month	*Inches*	*Days*	*Bagamoyo Average inches*
January	1·58	5	3·47
February	4·96	9	2·61
March	4·34	17	4·07
April	10·55	18	9·14
May	9·85	18	7·51
June	0·48	1	1·53
July	0·26	3	1·27
August	0·96	7	1·16
September	1·39	3	1·02
October	10·67	4	1·28
November	0·72	3	3·16
December	1·20	3	4·12
	46·96	91	40·34

Development

All the coconut plantations on the northern side of the station were cleared of bush and cultivated by tractor. They are now well kept but the surviving stand of palms is very poor. A 40-acre block of land in the south-west section of the station was cleared from heavy bush and planted with young coconuts during the long rains, together with all the land cleared but not planted in 1953. A further area of about 20 acres was cleared in December in preparation for planting cashew nuts in March/April, 1955.

In all about 120 acres of young coconuts were established in 1954, making the total acreage of young palms on the station approximately 180 acres, all planted since March, 1953. Of this area roughly 70 acres are utilized for extensive experimental layouts and the rest will be available for smaller experiments later if required. The policy followed has been to plant up complete blocks of land and then select within these blocks the areas suitable for experimental purposes. Thus the station is developed compactly and tidily as a plantation, the experiments being fitted in to the general development plan.

Production of Coconut Seedlings

Approximately 12,000 coconut seedlings will be available in March 1955. Of these the station will require 4,000 and the balance will be available for sale to the public. Demand considerably exceeds supply at present and it is hoped to increase the number available for sale to 25,000 in 1956.

Recording of some 10,000 trees has continued throughout 1954 and with yield records for 2½ years now available it is possible to select nuts from known high yielding parent palms for seed. A separate nursery has been established with these nuts but mass selection of good nuts from the heap has to continue in order to obtain sufficient numbers of seed nuts to meet the full seed requirements. Several thousand seedlings grown from nuts from high yielding parents are now available and although only one parent is known these seedlings should be superior to ones grown from mass selected nuts.

Revenue

Revenue for the Calendar year 1954 was Shs. 48,864/51. The figures for 1953 and 1952 respectively were Shs. 36,077/24 and Shs. 28,766/38. The sources of revenue are itemized below:—

	Shs.	Cts.
Sale of Copra	44,910	51
Sale of Coconuts...	1,384	62
Sale of Coconut seedlings	492	20
Sale of Other produce	1,546	18
Sale of Eggs and Poultry	486	00
Miscellaneous	45	00
Total ...	48,864	51

Although the coconut crop was smaller than in 1952 and 1953 revenue has continued to rise. This is in part due to an increase in the price of copra and in part due to increased efficiency in processing the crop on the station.

At the present level, revenue covers a substantial proportion of the normal recurrent maintenance costs of the station. When the 180 acres of young palms and the 20 acres of cashew nuts to be planted in 1955, come into bearing the revenue from the station should be nearly doubled.

Experimental Work

(a) *Coconuts.*—The two coconut experiments planted during 1953 were continued. Treatments were repeated where appropriate. The young palms have grown well but there are no differences in growth between palms in different treatments apparent to the eye. Very few palms have had to be replaced, although coconut beetle damage has been severe.

The method of establishment (inter-cropping) experiment has been completely uneconomic, (from the short term view point) no crops having resulted from the main rains plantings due to water-logging nor from the short rains plantings due to drought. It has continued to prove impossible to establish a cover crop, which is one of the treatments.

Tephrosia candida planted during the main rains succumbed to water-logging and has had to be discarded. *Glycine javanica* is now to be tried but since seed of it was obtained in November there has been insufficient rain to permit planting with any hope of successful establishment.

A fertilizer experiment including N.P.K. each at 3 levels in a 3^3 factorial design with two replications, was planted during the main rains with a basic treatment of cattle manure and husk in the planting holes. Establishment is excellent. The first fertilizer application will be made in January, 1955.

The Entomologist continued his investigations on the station into the control of coconut beetle.

(b) *Cashew Nut.*—The Portuguese East African and Zanzibar cashew nuts have made excellent growth. A small first crop of nuts would have been harvested but for the ravages of *Helopeltis* spp., which wiped out all the flowering shoots. The Entomologist is using the small blocks of cashew on the station to investigate methods of controlling *Helopeltis.*

(c) *Hibiscus.*—Trials continued with the most promising varieties of hibiscus. These are *Hibiscus cannabinus*, variety Laos, which is outstanding, *H. cannabinus* (Brazil), *H. cannabinus* (Cuba) and *H. sabdariffa* (Java Jute). The fibre obtained in 1954 was not as good as that in 1953 owing to the less favourable growing season. The report of the Colonial Products Laboratory on the 1953 samples was most encouraging, particularly as regards the Laos variety. Further samples were sent for assessment late in 1954.

(d) *Pineapples.*—Two fertilizer $\times$ mulching experiments, on a 2^4 layout, one under mature coconut shade, the other in the open, were planted in November with the Smooth Cayenne variety.

(e) *Cassava.*—A variety trial with mosaic-resistant cassava was planted in November. Establishment was poor owing to drought. Much of the surviving material has rapidly become infected with mosaic. Imported, allegedly resistant, varieties appear to succumb in the new environment, presumably because they encounter a form of the disease not present in the area in which they were selected or bred.

(f) *Sugar Cane.*—The sugar cane collection has been maintained. The presence of Ratoon stunting disease in some varieties was confirmed and the issue of planting material is still not possible. Several applications for material were received but had to be refused.

Food Crops

Five tons of maize were harvested; the yield per acre was small, but the crop was valuable in providing rations for fed labour. A small area of cowpeas was planted but yielded practically nothing owing to drought.

J. S. Gunn,
Agricultural Officer

GOVERNMENT FOOD FARM, LUPIRO
SUMMARY OF EXPERIMENTAL WORK FOR THE YEAR 1954

A total of 650 acres were prepared for rice planting but only 510 acres were eventually sown on account of the extremely wet conditions. 485 acres were combine-harvested giving a total yield of 405·25 tons paddy i.e. 830 kilos per acre. Considerable damage was done to the crop by trampling by game (elephant and hippo) and it is estimated that 36 tons of paddy were lost in this way. "Kahogo" the main variety grown lodged badly and it is evident that a variety more suitable for combining will have to be found.

Fertilizer trial.—A randomized block experiment using Nitrogen at 2 levels ($\frac{1}{2}$ cwt. and 1 cwt. per acre) and Phosphate at 2 levels ($\frac{1}{2}$ cwt. and 1 cwt. per acre) was laid down. Plots receiving the higher application of nitrogen and phosphate lodged badly. Differences in yield were not significant. Yield, number of heads, number of tillers and number of plants were all analysed. The regression of yield on number of tillers was just significant at the 5% level.

Seed rate/variety trial.—Seed rates of 65 lb., 88 lb., 100 lb. and 126 lb. per acre were tested on the two varieties used Kahogo and U.V.S. ex Swaziland. Kahogo produced a considerably higher yield than U.V.S. (significant at 0·1%). The differences in yield from the four different seed rates were not significant.

Herbicide trials.—Treatments:—

Pre-emergnce	(a) 2,4-D Amine salt at 1½lb. per acre.
	(b) 2,4,5-T Triethanolamine salt at 1 lb. per acre.
Post-emergence:	(a) 2,4,5-T Triethanolamine at ¾ lb. per acre.
	(b) 2,4-D Butyl ester at 1 lb. per acre.

All herbicides were effective in producing a resultant increase in yield (significant at 0·1%). Yield differences between the four separate herbicides were not significant.

H. E. Hubbard,
Field Officer (*Agriculture*)

SUMMARY OF THE ANNUAL REPORT OF MAHIWA EXPERIMENTAL STATION, SOUTHERN PROVINCE, FOR THE YEAR 1954

Rice

Rotation Experiment with four treatments (a) Kudzu, Kudzu, Rice, Rice, Rice; (b) continuous rice as control; (c) cassia loppings puddled in prior to rice each year and (d) rice followed by a catch crop of sweet potatoes. The experiment is now in its second year. There was no significant difference between treatments (in 1953 treatment (c) gave a significant difference). The sweet potatoes failed.

Manurial Experiment (residual) Treatments on rice in 1953 were:—

(a) complete artificials (2: 3: 2) at 2 cwt. per acre.

(b) 8·6 tons farmyard manure per acre.

(c) No manure—control.

No residual effect was shown up. This experiment will be abandoned and in its place a factorial trial will be laid down comprising 4 levels of sulphate of ammonia, 2 levels of super-phosphate and 2 levels of farmyard manure.

Variety trial.—Again no significant difference was obtained between the four strains of Kahogo rice. One strain (No. 3) has consistently given poorer yields and will be discarded and next year the three remaining strains will be tested against other varieties.

Contour Plot Experiment.—This trial compared swamp and hill varieties on contoured land, and it is shown that it is possible to grow swamp rice in contour plots with yields as good as hill rice although the former are much later in maturing. This trial will not be continued.

Weedicide Experiments.—Using "Fernoxone" weedkiller in single and double strengths to control grasses and sedges in rice, results were disappointing. The single strength weedicide had no effect whilst the double strength killed both rice and weeds. During 1955 it is hoped to test a number of weedicides.

Rice cum fish trial.—Four Malayan rice varieties were grown and 100 *Tilapia nilotica* plus 100 *T. melanopleura* put into two dams; 200 *T. nilotica* in a third dam and 200 *T. melanopleura* in the fourth dam. As resulted last year the rice yields were normal but the fish was a failure. Next year all varieties of rice will be grown in one dam together with 500 fingerlings of each variety of fish.

Cassava

Variety × Time of harvesting trial.—Seven varieties were grown and each harvested at five different periods. Varieties were:— 4023/3, 4029/10, 405/1, 4026/16, 4026/20, Binti Minzi and Local. Times of harvesting:— 15, 18, 21, 24 and 30 months after planting. Results show that the highest yields are obtained harvesting at 15 months, followed by 18 months, with the other three harvesting times showing no significant difference. Varieties local and 405/1 proved the best with variety 4023/3 the worst.

A spacing × method of cultivation trial was planted but results are not yet available.

Other work has been carried out on sorghum, cashew nuts, oil palms and sesame, and a long term rotational trial has been laid down comprising eleven rotations each lasting six years using various combinations of pigeon pea, cassava, sunflower, *Dolichos lablab*, sorghum, sesame, maize, groundnuts and grass.

SUMMARY OF THE ANNUAL REPORT OF MWANHALA AGRICULTURAL STATION, WESTERN PROVINCE, FOR THE YEAR 1954

Weather

The rainfall at the beginning of the season (November, 1953) was slightly above average but was well below average in February which was the driest on record and resulted in very adverse crop conditions. Total rainfall for the season was 23·27 inches as against an average of 33 inches.

Nineteen acres of the farm were used for agronomic trials.

The majority of the experiments were badly affected by drought and armyworm and once again gave very little results.

Fallow Manurial Trial Experiment M. 8. A.

Treatments

1. Sorghum and groundnuts	No manure, continuous cropping, control.	
2. Sorghum and groundnuts	3 tons shed manure per acre every 3rd year (applied 1953). Continuous cultivation.	
3. Sorghum and groundnuts	110 lb. single Super-Phosphate/per acre every 3rd year (applied 1953). Continuous cultivation.	
4. Tumbledown fallow	3 years grazed	Now in 2nd year. To be followed by 3 years of groundnuts and sorghum starting 1956.
5. Tumbledown fallow	3 years not grazed	
6. Pigeon pea fallow	3 years	
7. Cassava fallow	3 years	
8. Planted grass fallow	3 years grazed	

Crops grown in treatments 1, 2 and 3 were Wiru sorghum inter-cropped with Asilia groundnuts. Results this year were very poor and were not significant. In addition to the drought, effects were completely masked due to a very heavy Central shoot fly attack on the sorghum and Rosette infection of much of the groundnuts.

Fallow Manurial Trial Experiment M. 8. B.

The treatments are the same as in M.8.A. except that this experiment is in the first year and therefore treatments 2 and 3 received F.Y.M. and Super-Phosphate respectively. Crops and fallow crops are the same as in M.8.A. The grass fallow was *Cenchrus ciliaris* and establishment was poor. Results were again very poor and completely non-significant. Experiment M.9 was planted to give some information as to the value of two and three crop mixtures as compared with single stands. Combinations were tried using maize, groundnuts and sorghum. Results indicated a better monetary return per acre of maize and groundnuts inter-planted than any other combination. All combinations were significantly better at the 5 per cent point than sorghum alone or groundnuts alone.

Experiment M. 10.

A time of planting and method of cultivation trial. Treatments—3 planting dates each with flat, ridged and tie-ridged cultivation. The crops used were Katumbili maize inter-planted with Asilia groundnuts. The planting dates were 19th December, 19th January and 23rd February.

YIELDS IN KILOS PER ACRE

Cultivation	Maize				Groundnuts			
	1st Planting	2nd Planting	3rd Planting	Mean	1st Planting	2nd Planting	3rd Planting	Mean
Tie-ridged	162	229	69	153	74	6	0	27
Ridged	146	205	62	138	56	7	0	21
Flat	15	226	74	105	90	10	0	33
Mean	108	220	68	–	73	8	0	–

Significant Difference at 5% = 70.

Significant Difference at 5% = 36. Rosette infection was estimated at 28% in the first planting and 54% in the second planting.

Conclusions

The January plantings are far superior in the case of maize but for groundnuts the December plantings give a significantly better yield. There is an indication that tie-ridging is better than flat cultivation for maize but there is no difference with groundnuts. Too much importance cannot be attached, however, to these results due to the very poor growing conditions and the severe Rosette attack on the groundnuts.

EAST AFRICAN AGRICULTURAL AND FORESTRY RESEARCH ORGANIZATION FERTILIZER TRIALS, 1954

Five fertilizer trials were laid down in the Lake Province in 1954 but one was abandoned due to poor climatic conditions and heavy insect damage.

Five treatments were used, (a) control, (b) 200 lb. of Sulphate of Ammonia per acre, (c) 90 lb. Super-Phosphate per acre, (d) Nitrogen and Phosphate ((b) and (c)), 5 tons farmyard manure per acre. Various indicator crops were used comprising cotton, maize, bulrush millet and finger millet. On bulrush millet Nitrogen alone and Nitrogen and Phosphate gave good results. On maize F.Y.M. and Nitrogen plus Phosphate gave significant increases and a similar effect was obtained on cotton, whilst on finger millet very small differences occurred, F.Y.M. being not quite significantly better than control.

At Mwanhala Agricultural Station, Western Province a trial was laid down to test single applications and combinations with any two of the following treatments. (a) control, (b) 1 cwt. per acre Sulphate of Ammonia, (c) 1 cwt. per acre double Super-Phosphate, (d) 3 cwts. per acre Muriate of Potash, (e) 5 tons per acre kraal manure, (f) $1\frac{1}{2}$ tons per acre ground limestone. The indicator crop was Wiru sorghum and the weight of heads were measured in addition to the weight of the threshed grain. Nitrogen gave no result but Phosphate, kraal manure and limestone significantly increased grain weight and Potash significantly decreased the yield at the 1 per cent level, both for main effects and first order interaction. Potash also decreased the ratio of grain weight to head weight whereas kraal manure increased this ratio at the 5 per cent level.

At Mahiwa Rice Experiment Station, Southern Province a 3^3 factorial experiment was carried out using three different levels of Nitrogen Phosphate and Potash with split plots for farmyard manure application. The crop used was a dwarf sorghum Waxy Kaffir. The results have not yet been analysed.

NOTES ON EXPERIMENTS CARRIED OUT IN THE NORTHERN PROVINCE DURING 1954

A considerable experimental programme was carried out in the three districts of Mbulu, Moshi and Arusha, but not all trials were carried to a successful conclusion. Drought and birds ruined a number of trials in Arusha and Mbulu Districts, and large-scale organized praedial larceny in one maize field in Arusha completely ruined two experiments there.

Wheat variety trials revealed no varieties likely to oust established types, and the varieties 261R, WI and 294 continue to provide the bulk of the crop. The trial at Mbulu on the control of maize stalk borer with D.D.T. and B.H.C. dusts showed that while treatments significantly reduced the attack, this reduction was not reflected in increased yields. A manurial trial of wheat in Central Mbulu confirmed last year's trial, indicating that on soil similar to that on the Demonstration Farm, Mbulu, wheat will show a response to Phosphate and Nitrogen. Increases in yields of cotton and sugar following applications of irrigation water supplementary to the rainfall were obtained, but the optimum level of irrigation could not be determined from the experiments.

NOTES ON EXPERIMENTS IN THE TANGA PROVINCE, 1954

I.—USAMBARA AREA

Work done in 1954 has been a continuation of that done in 1952 and 1953, with appropriate alterations in the light of experience gained. In the Usambara area a total of 47 acres was under trial plots in 13 places, designed in the long run to give information of use in stabilizing the agriculture of the settled Usambara areas and in providing basic data on the cropping of possible expansion areas.

From a more immediate standpoint, objectives can be summarized as follows:—

(a) A continued comparison of the efficacy of ridged, tie-ridged or flat cultivation for various crops on varied soils and climatic conditions in the plains areas of Lushoto District.

(b) To compare as many different varieties of sorghum, cotton and groundnuts as possible in the marginal and sub-marginal maize and bean growing areas.

(c) Further trials with crops not grown in the district to find their suitability for the area.

(d) To experiment further with the reclamation by leaching and/or gypsum treatment of the land in dry areas proved by analysis to have highly saline soils. but for which irrigation water is available.

Details of two of the more important trials are given below.

Magoma

The trial plots of reclamation of saline rice land by leaching, gypsum and sisal waste application were re-planted, but yields were low being only in the region of one bag per acre as they were grown completely out of season due to pressure of other work at the proper planting time. Yields are normally lower in the second year than the first in saline soil reclamation, due to a breakdown in soil structure when most of the sodium has been removed, but they were undoubtedly further reduced due to the out of season planting, only made possible with copious irrigation water.

Drain Spacing Trial:

A plot 500 feet × 300 feet was split up into 10 sub-plots of irrigated rice 3 feet deep drains giving drain spacing distances of 100 feet to 200 feet in steps of 25 feet. Soil samples were taken from the centre of each plot before leaching and after leaching and will be taken again after harvest. Analyses of the first 2 sets of samples indicate that the 200 feet drain spacing is just as effective for salt removal as the 100 feet spacing employed in previous trials and it would appear that in the case of the free draining Magoma soil that the distance apart of leaching drains need be governed solely by the slope of the surface soil, as 200 feet apart on the site of the present trial is further than can be levelled for effective irrigation, without a great deal of labour.

Kwepala Reclamation and Rice Spacing Trials

This trial is located on the right-hand bank of the Luengera about 15 miles from Korogwe at the head of a large grassy flat of about 270 acres, easily irrigated.

Three plots measuring 75ft. × 87ft. were each subdivided into 3 equal parts for the spacing trial and these were planted as at Mwelia, with native method (one seedling about 18 inches × 18 inches), 6 inches × 6 inches with one seedling and 12 inches × 12 inches with 3 seedlings in each hole.

The large plots received treatment as follows:—

I.—6 tons of gypsum per acre.
II.—3 tons of gypsum per acre.
III.—Control—no gypsum.

Yields were as follows:—

Plot I: (a) 12 inches × 12 inches—1,400 lb. per acre.
(b) 6 inches × 6 inches—1,543 lb. per acre.
(c) Native planting—1,058 lb. per acre.
Plot II: (a) 12 inches × 12 inches—529 lb. per acre.
(b) 6 inches × 6 inches—1,014 lb. per acre.
(c) Native planting—396 lb. per acre.
Plot III: (a) 12 inches × 12 inches—485 lb. per acre.
(b) 6 inches × 6 inches—705 lb. per acre.
(c) Native planting—440 lb. per acre.

The yields particularly those of the 6 inches × 6 inches spacing which has proved itself to be the optimum spacing in previous trials, show a very marked linear response to gypsum treatment, due to the original high degree of sodium saturation which is now being replaced by calcium.

Conclusions to be Drawn in the Light of the Objects of the Experiments

(a) Contour ridging for the third year in succession gave much higher yields than the flat cultivation which is the local custom.

(b) The results of the 1954 plantings have added further evidence that sorghum and groundnuts are vastly superior to maize and beans as sources of food in the marginal maize and bean growing are of the Lushoto Plains. Cotton has again demonstrated that it is much the most suitable cash crop for the Plains, giving far the highest economic returns, whilst Ukiriguru-bred strains which this year on trial yielded up to 1,880 lb. of seed-cotton per acre have shown themselves locally superior to all other strains.

(c) Sorghum, groundnuts and cotton are all new introductions to the area.

(d) Results so far from reclamation trials are encouraging and indicate that it should be possible to reclaim a number of the saline soil types, found where irrigation water is available in the plains below the Usambaras, at fairly low capital costs, as economically profitable crops of rice, cotton, sorghum, groundnuts, chickpea and sunflower can be obtained even while the reclamation is in progress. The experiments will continue in 1955 as it is not thought that reclamation has yet reached completion on any of the trial plots.

II.—COASTAL AREA

Trials carried out at Burunge show that yields of pineapples are increased by heavy dressings (400 lb. per acre) of Sulphate of Ammonia or Sulphate of Potash but that practically no fruit is obtained in the first 18 months after planting unless a growth-promoting hormone is also applied.

The factorial fertilizer experiment on sorghum at Tanga Dairy was replanted and results have been analysed by East African Agriculture and Forestry Research Organization. Significant responses were found with applications of Farmyard manure and Nitrogenous and Phosphatic fertilizers. There is also a signficant response to Potash in the presence of Farmyard manure, but not without it.

Varietal trials on mosaic-resistant cassava strains continued; yields of all varieties being lower on the coastal sands than on the red earths of the hinterland.